A Scranton Gillette Publication

MAY 1961

WATER & SEWAGE WORKS

WATER SUPPLY • SEWAGE DISPOSAL

Bascule gates under construction to increase reservoir capacity . . . p. 163

UNIVERSITY MICROFILMS
313 N. 1ST ST.
ANN ARBOR, MICH.
COMP

METROPOLIS OR MOUNTAIN TOP

PILE SLEEVE OR PIPELINE

LOCK JOINT PIPE COMPANY products for a variety of purposes are offered on a world-wide market. The majestic New York skyline looks down on a bargeload of 144″ Lock Joint Concrete Subaqueous Pipe en route to a metropolitan sewer outfall project, as well as on Lock Joint Concrete Pile Sleeves being installed for the Port Authority's pier construction program.

15,000 feet up on the bleak slopes of the Andes, the installation of 40 miles of Lock Joint Concrete Pressure Pipe made vital water available to the Southern Peru Copper Company's $300,000,000 mining enterprise.

So it is throughout the world. Lock Joint products are bringing fertility to the Negev Desert. Additional water flows to thriving Cape Town through a Lock Joint supply line. Lock Joint transmission and distribution mains as well as sewer lines help meet greatly increased demands in booming Caracas. These are only a few of the thousands of communities at home and abroad served with complete satisfaction by Lock Joint Pipe Company.

LOCK JOINT

CONCRETE PIPE

LOCK JOINT PIPE CO.

East Orange, New Jersey

Member of the AMERICAN CONCRETE PRESSURE PIPE ASSOCIATION

Sales Offices: Chicago, Ill. • Columbia, S.C. • Denver, Col. • Detroit, Mich. • Hartford, Conn. • Kansas City, Kan. • Perryman, Md. • St. Paul, Minn. • Winter Park, Fla.

Pressure • Water • Sewer • REINFORCED CONCRETE PIPE • Culvert • Subaqueous

SEE THE ORIGINAL 1858 MODEL OF THE "MATHEWS" FIRE HYDRANT

at the
AWWA 81st Annual
Conference
June 4 to 9, 1961
Cobo Hall, Detroit, Mich.

This is the actual model of a "Mathews" hydrant submitted in 1858 to the U.S. Patent Office with the first patent application—over 100 years ago. The design of this historic hydrant proved to be so ingenious that it has patterned all succeeding models—only advanced engineering refinements have been made. This and models of modern R. D. Wood Hydrants and Gate Valves will be on display in Booth Nos. 409 and 411. A warm welcome awaits your visit.

R. D. WOOD COMPANY

Established in 1803

Public Ledger Building
Independence Square
Philadelphia 5, Pa.

Manufacturers of "Sand-Spun" cast iron pipe (centrifugally cast in sand-lined molds) and R. D. Wood Gate Valves

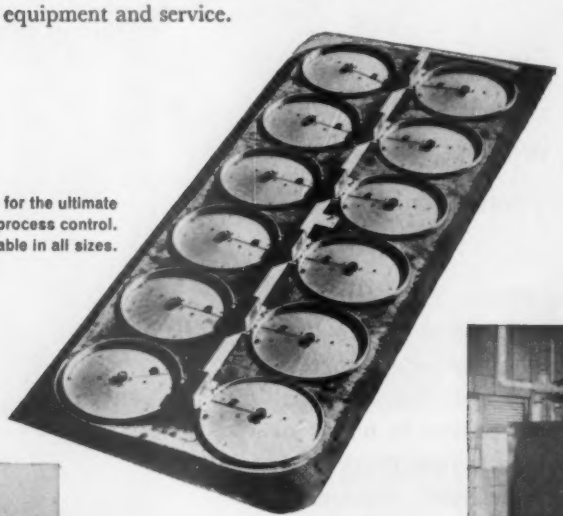
P.F.T.

assurance of the best

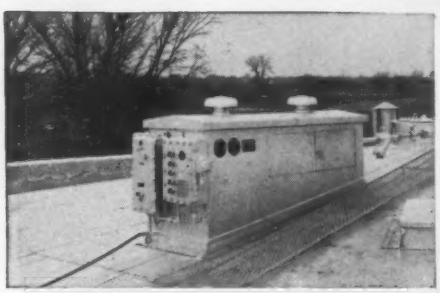
When specifications demand the best in waste treatment equipment the name P.F.T. is the name remembered.

Equipment by P.F.T. is modern and of advanced design, a blend of rugged construction and precision manufacture assures the consulting engineer, as well as his client, satisfaction and trouble-free operation— an assurance of the best.

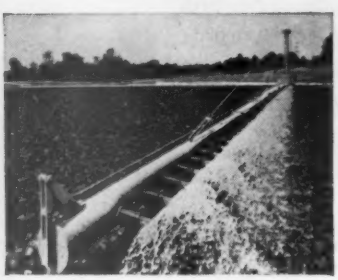
P.F.T. is the name recognized as outstanding in process and equipment for over sixty years. When you specify P.F.T. you specify quality equipment and service.



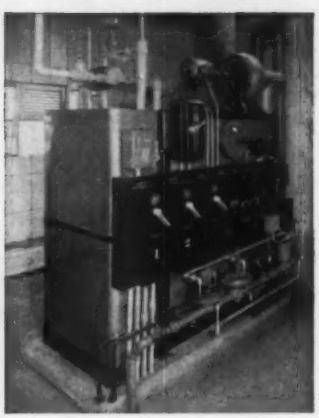
P.F.T. Floating Cover Digesters for the ultimate in flexibility and digestion process control. Available in all sizes.



P.F.T.-Pearth Gas Recirculation System. Increases rate of digestion and eliminates scum accumulations.



P.F.T. Rotary Distributors featuring P.F.T. Spreader Jets provide uniform distribution.



P.F.T. Digestion Heaters, available for any size installation using sludge gas. Adaptable to use any commercially available auxiliary fuel.

P.F.T.

waste treatment equipment exclusively since 1893

PACIFIC FLUSH TANK CO.

4241 RAVENSWOOD AVENUE, CHICAGO 13, ILLINOIS

PORT CHESTER, N.Y. • SAN MATEO, CALIF. • CHARLOTTE, N.C. • JACKSONVILLE • DENVER

WATER & SEWAGE WORKS

VOL. 108 NO. 5

MAY 1961

A Scranton Gillette Publication

E. SCRANTON GILLETTE
Publisher

V. W. LANGWORTHY
Editor

C. F. GURNHAM
Consulting Editor

Contributing Editors

D. P. Beckmeyer — R. E. McKinney
J. R. Baylis — R. C. Merz
P. D. Haney — A. M. Rawn
C. E. Keefer — R. W. Simpson
J. F. Dye — W. A. Cawley

CHICAGO OFFICE: 185 N. Wabash Ave.
E. S. Gillette, Publisher
H. J. Conway, Adv. Ed.
V. W. Langworthy, Editor
E. J. Hoeffer, Asst. Editor
C. Terrazas, Asst. Editor
E. E. Helmos, Jr., Construction Editor
W. W. Hamilton, Western Sales Mgr.
R. J. Rooney, Make-up Editor
R. L. Fienberg, Copy Editor
M. McGinnis, Edit. Secy.

NEW YORK OFFICE: 155 East 44th St.
T. M. Todres, Administrative Assistant
Wm. R. Joyce, Midwestern Sales Mgr.
Terence McCoy, Eastern Sales Mgr.

85 Post St., San Francisco 4, Calif.
Duncan A. Scott & Co.

1901 West 8th St., Los Angeles 5, California
Duncan A. Scott & Co.

1201 Forrest Lane, Birmingham 9, Ala.
Fred W. Smith, Sales Rep.

Published and Copyrighted 1961 by Scranton Publishing Co., Inc.

Contents

FEATURES

Bascule Gates for Increasing Reservoir Capacity 163
by Gordon E. Thomas

Evaporation Supression Research, Part I (Research Progress Report) 167
by Joseph B. Franzini

Dis-organization Man 172
by Partially Oriented

Activated Sludge Process Control 173
by Brian L. Goodman

Algae Growth Rate (Research Progress Report) 176
by Wesley O. Pipes, Jr.

Flow Velocity in Partly Filled Pipes 180
by Richard Pomeroy

Application of Fluorides to Water 183
by William T. Ingram

Synthetic Detergents in Ground Waters, Part I 188
by Louis G. Campenni

Microstraining Helps Kenosha 192
by O. Fred Nelson

Installing a Sewage Lagoon and Lift Stations 194
by Donald L. Floan

Repairing Steel Pipe—The Hard Way 198
by Kurt A. Gruber

Compressed Air Revives Polluted Swedish Lakes 200
By William A. Heath

Coagulant Aids as Filter Aids 201
by W. R. Conley and R. W. Pitman

Editorial—A Lesson and a Moral 203

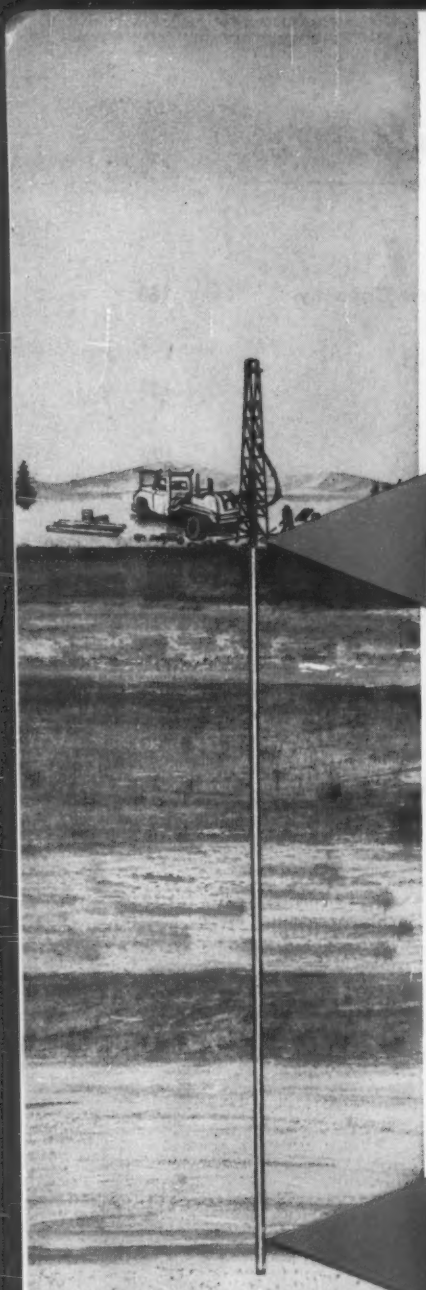
New Potassium Permanganate Technique 204
by S. Bruce Humphrey and Maurice A. Eikelberry

DEPARTMENTS

News—Here & There 6A
Washington Viewpoint 12A
Meetings 42A
New Literature 100A
Keep 'em Rolling 95A
Equipment News 96A
News of Suppliers 98A

FUTURE FEATURES . . .

Discussion of Synthetic Detergents—Part 2
Evaporation Suppression Research — Part 2
Methods of Measuring Coliform Content
Instrumentation in Water Pollution Control
Butterfly Valve Operators — Part 1



Layne SINCE 1882

Layne Vertical Turbine Pumps are designed, engineered and manufactured by Layne in Memphis, Tennessee and nowhere else. Because pumping needs vary, there is a Layne pump for every pumping requirement—from 30 to 100,000 G.P.M. in sizes from 4 to 42 inches. Layne Pumps include Deep Well and Short Coupled (oil or water lubricated), Propeller, Mixed Flow, Regular and "In-Line" Submersible. For additional information write for bulletins 200-oil lubricated or 201-water lubricated.

has the only complete service that means

Water

The Layne Gravel Wall Well is an example of Layne experience, engineering and research. This gravel packing and 134 shutter screen employment affords larger screen openings, reduced friction, reduced draw down and pumping head. It increases specific capacity and makes for more effective retention of native sands. For additional information write for bulletin 900.

From top to bottom, you can depend on Layne for the most complete water service in the industry. This complete service provides undivided responsibility for the delivery of water . . . of the quality and in the quantity required. Over 75 years of *growing* service gives the skill and technical know-how which makes Layne First in the field of water. For additional information write for bulletin 10.

LAYNE OFFERS COMPLETE WATER SERVICE:

Initial Surveys • explorations • recommendations • site selection • foundation and soil-sampling • well drilling • well casing and screen • pump design, manufacture and installation • construction of water systems • maintenance and service • chemical treatment of water wells • water treatment—all backed by Layne Research.

Layne services do not replace, but coordinate with the services of consulting, plant and city engineers.

Layne

LAYNE & BOWLER, INC., MEMPHIS

General Offices and Factory, Memphis 8, Tenn.

LAYNE ASSOCIATE COMPANIES THROUGHOUT THE WORLD

SALES REPRESENTATIVES IN MAJOR CITIES

Visit the Layne booth 213-215, AWWA CONVENTION, June 4-8, Cobo Hall, Detroit

Briefs

Bascule Gates for Increasing Reservoir Capacity—The features of this type of gate and a discussion of several installations are presented—Page 163.

Evaporation Suppression Research (Research Progress Report), Part I of a two part series examines the possibility of increasing available water by reducing that fraction of rainfall which is evaporated before it can be used—Page 167.

Dis-organization Man tells of Partially Oriented's efforts to become a first-class "Organization-Man"—Page 172.

Activated Sludge Process Control. ORP test methods have been widely advocated for the study and control of waste treatment processes—Page 173.

Algae Growth Rate (Research Progress Report) explains how organic compounds can accelerate the algae growth rate in stabilization ponds—Page 176.

Flow Velocity in Partly Filled Pipes are calculated more simply with an equation explained and demonstrated in this study—Page 180.

Application of Fluorides to Water demonstrates how the application systems for fluoride bearing chemicals vary in cost, maintenance and details—Page 183.

Synthetic Detergents in Ground Waters. Part I of a two part series tells how detergents contaminating ground waters caused the FHA to revise its requirements for mortgage insurance acceptability of homes—Page 188.

Microstraining Helps Kenosha. Installation of a Microstrainer enabled this city to control algae growth and thus increase its water supply capacity—Page 192.

Installing a Sewage Lagoon and Lift Stations concerns a new up-to-date sewage disposal system which handles the sewage and industrial wastes from a city of 7000 people—Page 194.

Repairing Steel Pipe—The Hard Way, and a hard way it was for this crew fighting not only rust and corrosion but also the hazardous conditions encountered in Tropical areas—Page 198.

Compressed Air Revives Polluted Swedish Lakes—By introducing oxygen to their lakes' waters, Swedish engineers have revived sources of water supply—Page 200.

Coagulant Aids as Filter Aids. Better results, less cost, increased capacity and faster personnel training are the benefits derived from using organic polymers as filter conditioners—Page 201.

Editorial—A Lesson and a Moral points out that adverse publicity can hurt the industry's chances for rapid improvement—Page 203.

New Potassium Permanganate Techniques now make possible the convenient removal of tastes and odors, iron, manganese and hydrogen sulfide from water supplies—Page 204.

Bond Usage Studied by Louisville Chamber of Commerce

According to a survey conducted by the Louisville Chamber of Commerce, general obligation bonds are widely used by major cities throughout the nation to finance water and sewer services. However, the Chamber's study pointed out, the City of Louisville and Jefferson County issue only revenue bonds when borrowing to finance such construction.

Because they are backed only by the revenue of the water or sewer district, revenue bonds cost more in interest. General obligation bonds are backed by the full credit of the city and/or county.

Research Director Richard K. Harb prepared the Chamber's study. Although it did not recommend switching to general obligation bonds by the City of Louisville, it noted that 77 per cent of 22 sewer districts surveyed issue general obligation bonds, frequently in combination with revenue bonds. Only 21 per cent finance exclusively with revenue bonds including, as noted, Louisville's Metropolitan Sewer District.

Among municipally owned water companies responding to the query, five use general obligation bonds and two, including Louisville, use revenue bonds. One uses both. The information for the survey was obtained through chambers of commerce in other cities.

Water & Sewage Works is published monthly with an extra issue in August. Subscriptions including the Reference Number issue in the U.S. and Canada, 1 year $5.00; 2 years $7.50; 3 years $10.00. Other countries $1.50 per year additional. Single copies 50c except Reference Number $1.00.

MAIL SUBSCRIPTION ORDERS and CHANGES OF ADDRESS to Water & Sewage Works, 185 North Wabash Ave., Chicago 1, Illinois. Please allow four to six weeks for corrections to be effected.

E. Scranton Gillette, President; C. T. Gillette, Secretary; and H. J. Conway, Treasurer.

•

Water & Sewage Works, Reg. U.S. Patent Off. Published monthly by Scranton Publishing Co., Inc., at 185 N. Wabash Ave., Chicago 1, Ill. Entered as second class matter at the post office at Pontiac, Ill., under Act of March 3, 1879.

News—Here & There

Industrial Wastes Committee Meets

The National Technical Task Committee on Industrial Wastes, a nationwide group of industry engineers advisory to the U. S. Public Health Service and the Water Pollution Control Advisory Board, convened at Cincinnati during April for their second biennial research meeting. Business meetings are held annually in December.

At the April meeting, outstanding scientists of the Sanitary Engineering Center discussed with the Committee their current and proposed research activities. On the agenda were: water pollution problems arising from the new products of industry; advances in water treatment methods; automated monitoring of stream quality; practical methods for water conservation; and improved application of natural purification processes. NTTCIW Chairman Lloyd Jensen, of the Great Western Sugar Company, presided at this two-day conference.

Crystal-clear water... and every drop free of germs, algae, and fungi. HTH releases effective, dependable chlorine that sanitizes new pipe lines, protects wells and reservoirs, too. Comes in either free-flowing granular or convenient tablet form. Packed in new, easy-to-handle 3¼-lb. plastic bottles, 35-lb. pails and 100-lb. metal drums. Write for literature, to: OLIN MATHIESON, Baltimore 3, Md.

Here's to Health... **HTH**®

9311 **CHEMICALS DIVISION** **Olin**

Simon Elected to ASA Board

Carl H. Simon has been elected to the board of directors of the American Standards Association for a three-year term.

Mr. Simon is executive vice president and general manager of Darling Valve & Manufacturing Co., Williamsport, Pa., and vice president of its two Canadian subsidiaries. He will represent the valve and fittings industry on the ASA Board.

For the past five years, Mr. Simon has been first vice chairman of the Manufacturers Standardization Society of the valve and fittings industry and chairman of its executive committee. He is a member of the ASME, the AWWA, the American Petroleum Institute, the American Management Association, and the ASTM.

St. Joseph, Mo. Finally Passes Bond Issue

The passage of a $5,955,000 bond issue in St. Joseph, Missouri, on Tuesday, April 11, removes the major remaining barrier in a Federal-State program to clean up the Missouri River, Secretary of Health, Education, and Welfare Abraham Ribicoff said today. The bond issue was approved by a vote of 10,502 to 3,789.

"By an overwhelming vote, the people of St. Joseph have assured the success of the great task of restoring the entire Missouri River to safe and usable condition," the Secretary said. "This program, to which St. Joseph is now prepared to make a positive contribution, will become one of the major milestones in the Nation's total effort to safeguard its vital water resources."

The election came after the Federal Government had brought suit against the city of St. Joseph for its pollution of the Missouri. The suit was filed under the enforcement provisions of

CONTINUED ON PAGE 8A

Vibration from speeding trains won't cause leaks in this

TYLOX-JOINTED SEWER LINE

Here's a mountain that gets "shook up" each time a train thunders through the cut. The pipe line being installed beside the tracks will get "shook up," too, but it won't spring leaks at the joints and thus endanger the stability of the roadbed. In specifying TYLOX RUBBER GASKETS for coupling the pipe, designers not only assured the safety of the railroad subgrade, but put their sewer project ahead in three important ways . . .

NO INFILTRATION—Rubber TYLOX seals by compression, preventing leakage in or out of the pipe. Cost of sewage treatment is reduced . . . root and sediment problems are eliminated.

NO JOINT FAILURES — Flexible TYLOX safely absorbs soil stresses, shock loads and severe vibration. Under ground and under compression it never deteriorates. TYLOX lasts for the life of the pipe itself.

NO INSTALLATION DELAYS—fast working TYLOX permits wet-trench jointing and immediate backfilling. TYLOX reduces pipe installation costs.

* **PROJECT:** Tumwater sanitary sewer, Olympia, Washington. (1500 ft. parallel to main line of the Union-Pacific Railroad into Olympia, Wash.)

ENGINEERS: Carey & Kramer, Consulting Engineers, Seattle, Washington.

CONTRACTOR: Harold Koeser Co., Seattle Washington.

PIPE: Tylox-jointed 18" reinforced concrete, manufactured by **GRAYSTONE** of Olympia, Inc., Olympia, Washington.

5073

Write for new Tylox brochure!

Read the facts on TYLOX and see why it is specified for important pipe jobs all over the world. **Specify** TYLOX to assure economy, safety and longevity on **your** pipe projects.

HAMILTON KENT MANUFACTURING COMPANY

KENT, OHIO

427 West Grant Street Orchard 3-9555

News—Here & There

CONTINUED FROM PAGE 6A

the Federal Water Pollution Control Act, which is administered by the Department of Health, Education, and Welfare. Along the Missouri all other cities coming under the provisions of the Act are complying with Federal directives including Omaha, Sioux City, and Kansas City, Missouri, and Kansas City, Kansas. St. Joseph is the only city in the Nation to be subjected to court action under this Act to date.

The case is now on the docket of the U. S. District Court in Kansas City. It was called up on March 9, but the judge postponed the setting of a trial date until after the referendum.

The St. Joseph case began nearly four years ago, on June 11, 1957, when a conference disclosed that wastes from the city and 18 industries in the St. Joseph area were causing serious pollution of the river. The industries subsequently agreed to take steps to treat their wastes but the residents of St. Joseph twice refused to do so, voting down one bond issue for this purpose in 1958 and another in 1960. After a public hearing the Federal Government brought suit against the city at the request of the Kansas State Board of Health and with the concurrence of the Missouri Water Pollution Control Board.

Directory of Texas Water & Sanitation Agencies

More than 800 agencies, offices, and organizations are engaged in activities bearing on water for Texas. The majority of these, over 660, are agencies and subdivisions of the State government.

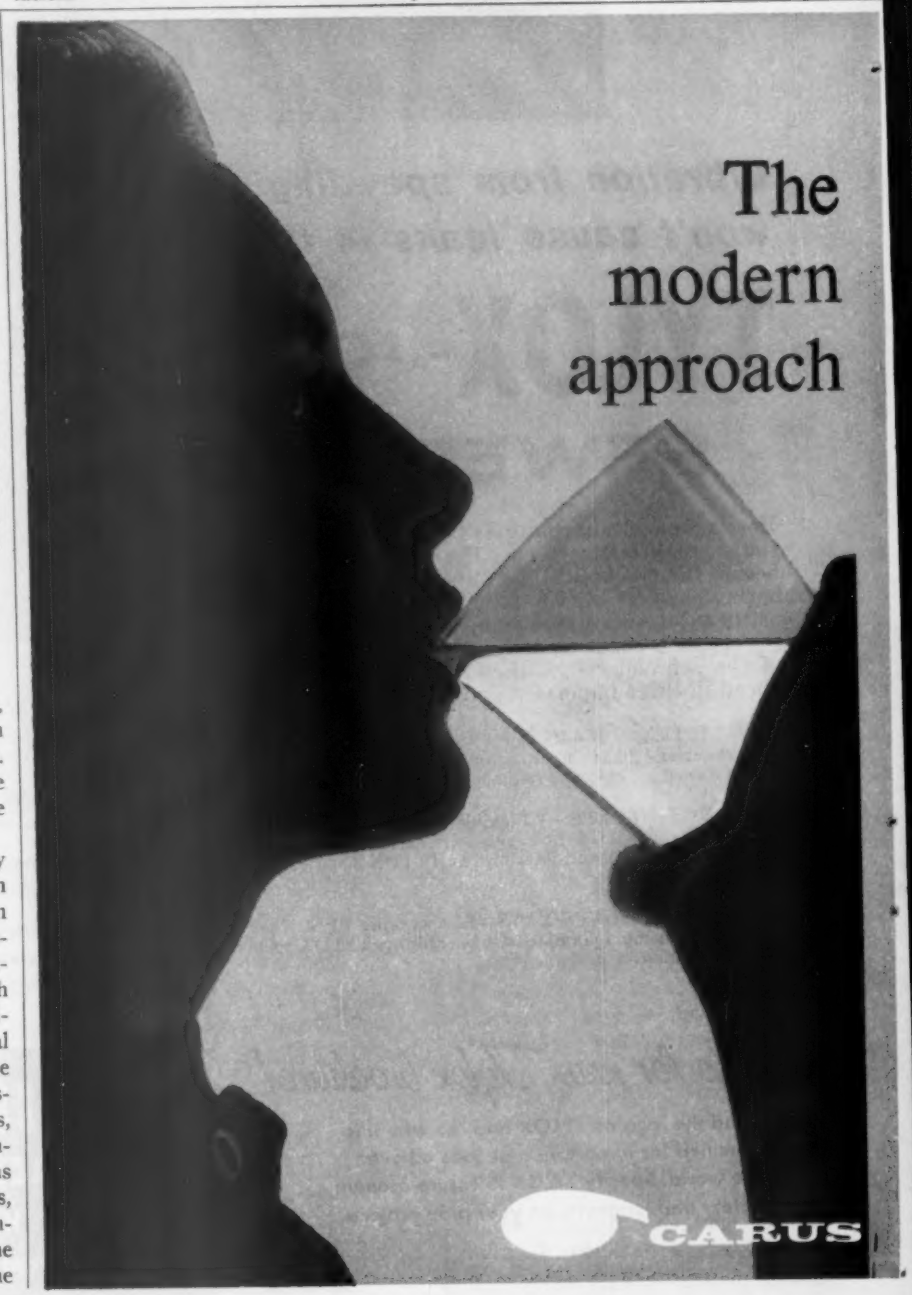
This is one of many facts that may be learned from a new publication "Directory of Water and Sanitation Agencies in Texas 1960" just published as a public service by the Texas Water and Sanitation Research Foundation. Listed in the 52-page directory are the State and Federal executive and legislative agencies, the Water Control and Improvement Districts, Soil Conservation Districts, other special districts, and the scientific societies and other associations with their committees, local sections, and other groups. Each listing contains a mailing address and the name of at least one individual officer. The scope of their activities is indicated in many cases. Omitted from this first edition are municipal water departments and water supply companies.

The Directory may be purchased (price $2.50) from the Foundation's Executive Secretary, Dr. Louis Koenig, 6702 Blanco Road, San Antonio. Koenig revealed "the next enterprise will be a directory of agencies and individuals actually performing research in Texas in water and sanitation."

Eliassen Joins Staff at Stanford U.

Dr. Rolf Eliassen will join the Stanford University faculty as professor of civil engineering on September 1. He will fill a new position made possible through a $32,500 training grant from the U.S. Public Health Service.

Dr. Eliassen will bolster the University's teaching aims in the field of public health and water resources.



He will also work with other members of the engineering faculty on Stanford's program in engineering-economic planning.

A specialist in pollution control in the development of water resources, he is now acting head of the Department of Civil and Sanitary Engineering at Massachusetts Institute of Technology, where he has been since 1949. He is internationally known for his studies of the disposal of atomic wastes. He is a consultant to the U.S. Public Health Service and the International Atomic Energy Agency of the UN.

Extended Aeration Sewage Treatment Plants Evaluated

An evaluation of extended aeration sewage treatment plants now in service throughout the United States has been prepared at the U. S. Public Health Service's Robert A. Taft Sanitary Engineering Center, Cincinnati, Ohio. The report, "Extended-Aeration Sewage Treatment—A Preliminary Evaluation," was produced by personnel of the Field Operations Section of the Public Health Service Division of Water Supply and Pollution Control Technical Service Branch.

The survey which was limited to plants serving from 20 to 2,500 population, revealed that use of small extended-aeration sewage treatment plants is increasing. There were 1,224 plants reported in service or under construction as of July 1, 1960. Only four States, New Hampshire, New Mexico, Nevada and North Dakota, reported no plants in use; while six States, Ohio, Pennsylvania, Kentucky, Illinois and Indiana, reported 849 or approximately 70 per cent of the total.

The report reviews the varying application of extended-aeration plants and presents data on their performance, design requirements, construction and operating costs and information on requirements by various states.

Copies of "Extended-Aeration Sewage Treatment—A Preliminary Evaluation," Sanitary Engineering Center Technical Report W60-6, may be obtained by writing to Director, Robert A. Taft Sanitary Engineering Center, 4676 Columbia Parkway, Cincinnati 26, Ohio.

Conference on Evironmental Engineering and Metropolitan Planning

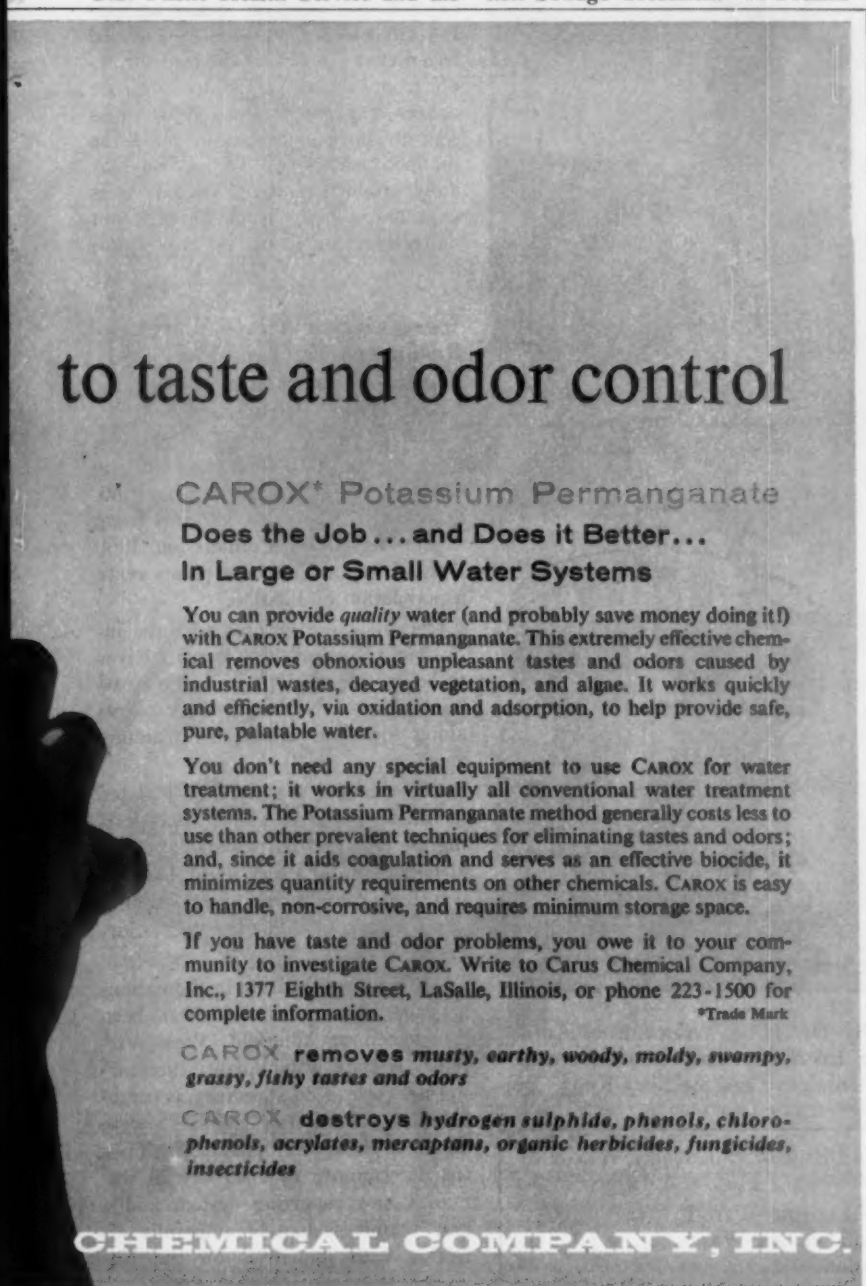
More than 300 experts on problems resulting from America's growing urban areas met March 21 and 22 for a Conference on Environmental Engineering and Metropolitan Planning at Northwestern University.

The purposes of the Conference were to exchange information on the latest technical developments in common problem areas, to create interest in more badly needed research, and to build closer cooperation between specialists in the two fields.

Papers were presented on problems such as water supply, flood control, air and water pollution, human and industrial wastes treatment control and atomic waste handling.

The Conference was co-sponsored by the Public Health Service of the U.S. Department of Health, Education and Welfare, the Northeastern

CONTINUED ON PAGE 10A


to taste and odor control
CAROX* Potassium Permanganate
Does the Job ... and Does it Better...
In Large or Small Water Systems
You can provide quality water (and probably save money doing it!) with CAROX Potassium Permanganate. This extremely effective chemical removes obnoxious unpleasant tastes and odors caused by industrial wastes, decayed vegetation, and algae. It works quickly and efficiently, via oxidation and adsorption, to help provide safe, pure, palatable water.
You don't need any special equipment to use CAROX for water treatment; it works in virtually all conventional water treatment systems. The Potassium Permanganate method generally costs less to use than other prevalent techniques for eliminating tastes and odors; and, since it aids coagulation and serves as an effective biocide, it minimizes quantity requirements on other chemicals. CAROX is easy to handle, non-corrosive, and requires minimum storage space.
If you have taste and odor problems, you owe it to your community to investigate CAROX. Write to Carus Chemical Company, Inc., 1377 Eighth Street, LaSalle, Illinois, or phone 223-1500 for complete information.
*Trade Mark
CAROX removes musty, earthy, woody, moldy, swampy, grassy, fishy tastes and odors
CAROX destroys hydrogen sulphide, phenols, chlorophenols, acrylates, mercaptans, organic herbicides, fungicides, insecticides
CHEMICAL COMPANY, INC.

News—Here & There

CONTINUED FROM PAGE 9A

Illinois Planning Commission and Northwestern University.

It was the first meeting to be jointly sponsored by three of the key professions involved in metropolitan planning.

Cooperating in planning the conference were the American Institute of Planners, American Municipal Association, American Public Works Association, American Society of Civil Engineers (Planning and Sanitary Engineering Divisions), American Society of Planning Officials, American Water Works Association and International City Managers Association.

The conference could prove to be a landmark in building cooperation between environmental engineers and planners.

Gotaas Attends International Water Pollution Meeting

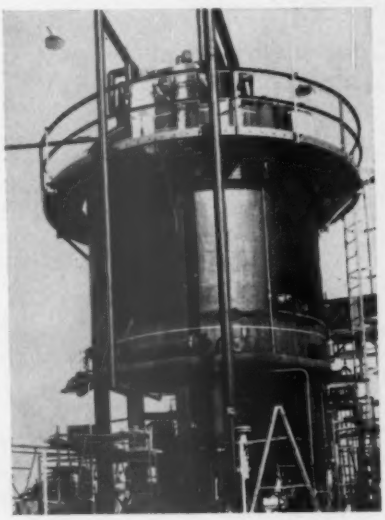
Dr. Harold B. Gotaas, dean of the Technological Institute at Northwestern University, was one of three Americans to attend an international meeting on water pollution research held March 7-8, in Paris. The meeting was sponsored by the Organization for European Economic Cooperation and were "hopefully" designed to lead to coopertion in European research in this field. Traditionally, each European nation has done its own pollution research and operated its own laboratories. It is hoped that now duplication of effort will be diminished and, perhaps, new research projects will be created.

Gotaas is a recognized authority in water treatment and sanitation. In 1958, he and co-worker William Oswald received the James R. Croes medal and the Rudolph Hering medal of the ASCE. This was the first time the Society gave two medals to one man for research in a year. The award was for the published paper, "Photosynthesis in Sewage Treatment".

Salt Water Conversion Plant

The missile shaped Melter-Washer tower of the new salt water conversion plant on Weedon Island in

Tampa Bay is one of a series of saline conversion plants sponsored by the Office of Saline Water. It utilizes



by Dr. H. F. Wegandt of Cornell a freezing process system developed University and the Blaw-Knox Company of Pittsburgh.

Designed to produce ice crystals, which are pure water, salt water and liquid butane are pumped into either the tower at the left (top) or a rotating basket device being insulation in the picture at the left (bottom). As the butane turns to a gas, it pulls heat from the salt water, creating a slurry of ice in the brine. The brine is next drained from the slurry and the ice crystals washed clear of any remaining salt water. The ice is then moved to a melter unit where the heat throw-off from butane gas under pressure causes it to melt. Potable water is sent to storage tanks and the brine dumped backed in Tampa Bay. A daily production of 35,000 gallons is expected, and the target price is not more than fifty cents per 1,000 gallons.

West Virginia State Water Resources Commission Annual Report for Fiscal Year 1960

Twelve new sewage treatment plants went into operation in the State of West Virginia during 1960, according to the West Virginia State Water Resources Commission 1960 Annual Report. The new plants serve a population of 136,036.

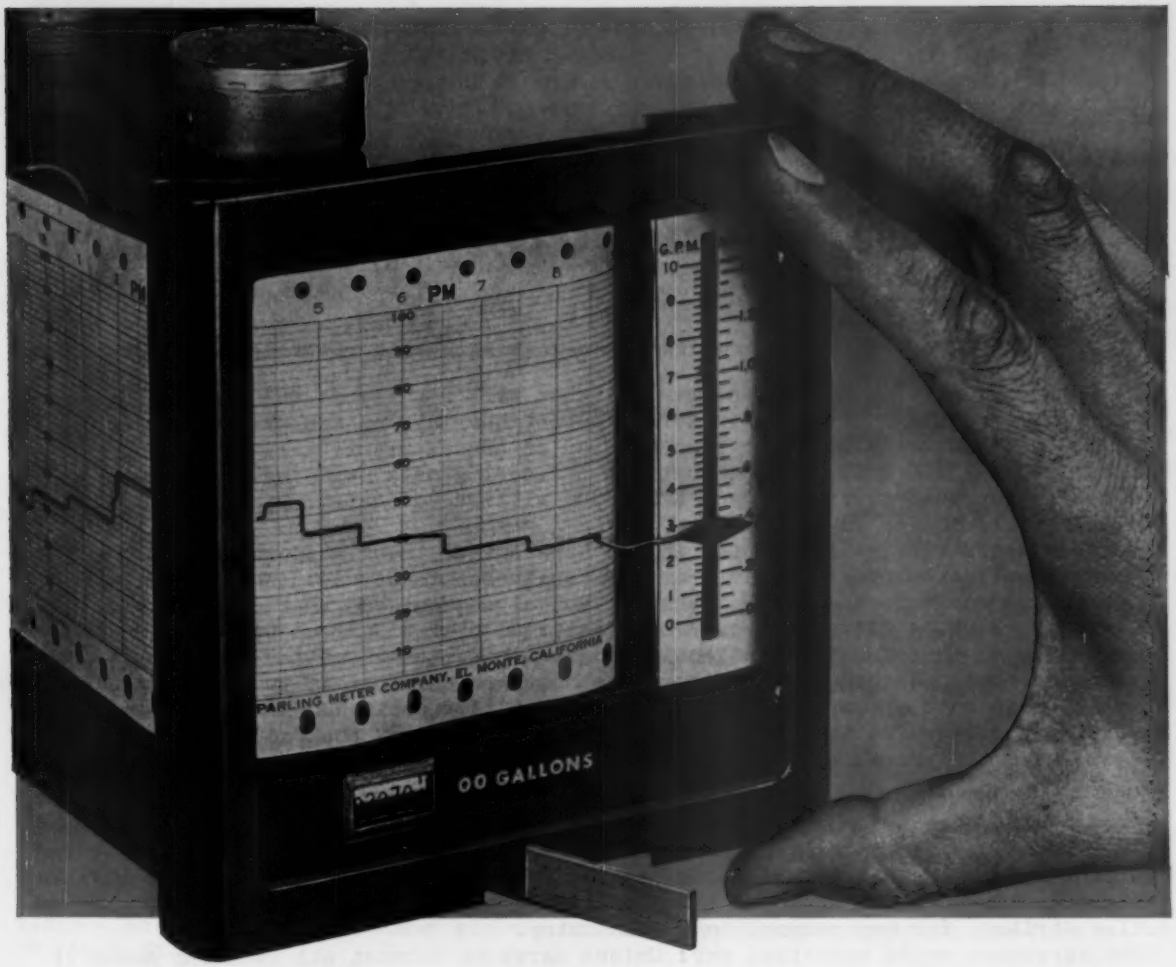
Permits were granted to three industrial plants on the Kanawha River to begin construction on waste treatment plants, and other major plants along the river are in the planning stage.

Sixteen coal washeries completed facilities for waste clarification during the year and funds were appropriated by the Legislature to begin a water resources inventory in cooperation with the U.S. Geological Survey.

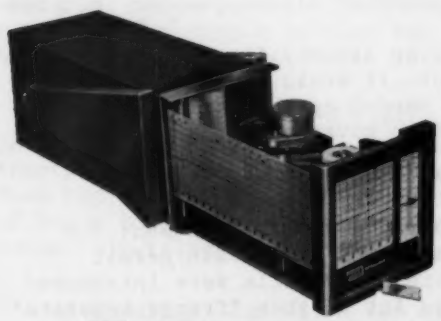
A monitoring station in the national water quality network has been established at Winfield, West Virginia. A state water quality monitoring network of 34 stations was established. Laboratory facilities were about doubled and include facilities for determining radioactivity in water. A new reporting system and a new permit system became fully effective with industries on the Kanawha River during the year.

Recommended reading in March-April issue of INDUSTRIAL WATER & WASTES:

Acrylonitrile and Zinc Wastes Treatment—Part 1
An Incinerator for Uranium Contaminated Wastes
Anaconda Micro-strainer Installation



New SPARLING MINIATURE STRIP CHART INDICATOR • TOTALIZER • RECORDER



COMPLETE FLOW INFORMATION IN LESS THAN 1/4 PANEL SPACE

Indication, *totalization* and recording—the same as in full size instrumentation—are all provided in this new, compact unit. Uses standard components, yet requires little more than 6" square panel area. Has 6-digit totalizer, dual equivalent scales, and effective range of 20:1. 60 or 120 day records. When chassis is removed, 26 hours of records are visible without moving chart. Ideal for graphic or conventional panels, and standard electronic racks. WRITE FOR TECHNICAL BULLETIN CF-390.

Sparling equipment includes a complete line of instruments, controls and propeller meters for all main-line requirements.

SPARLING
WATER CONTROL EQUIPMENT

HERSEY-SPARLING
METER COMPANY
Sparling Equipment: **EL MONTE, CALIF.**
225 North Temple City Blvd.

Branches: Atlanta • Chicago • Cleveland • Dallas • Denver • Kansas City, Mo. • Roselle, N. J. • San Francisco • Seattle • United Kingdom Affiliate: TYLORS OF LONDON LTD.

Washington Viewpoint

The shape of the pollution control bill that will finally go to Congress for action was beginning to emerge in April, out of hearings on Rep. Blatnik's HR 4046. As expected, Blatnik's call for $125 million in annual grants will most likely be compromised at $100 million; combinations of local grants, or single grants up to $1 million (as opposed to the present $250,000) will be advocated. Otherwise, there will be little change in the proposal.

But engineers will be interested in the apparently strong support for shifting the whole pollution program away from the Public Health Service (see March issue for details) and into engineering hands. Typical comment was that of Rep. John D. Dingell (D. Mich.): "I've been extremely critical of the Surgeon-General's office. It seems to me that funds for pollution control have been used for inspecting train toilets, crabmeat canning activities—there has been only polite investigation of causes, deliberate attempts not to rock the boat. Air pollution problems have been miserably handled. The pollution problem must be free from the foot-draggers of the Surgeon General's bureaucracy."

* * *

Probably biggest news of all for anyone in the construction industry was in the making in Washington in mid-April: A real prospect of labor peace. The prospect was contained in a broad agreement being negotiated between the 7,500-member Associated General Contractors and seven of the top Building Trades unions. It would flatly outlaw strikes, for any reason, in the industry.

The agreement would work this way: Unions agree to exhaust all existing means of settling disputes (but not jurisdictional disputes which, as you know, are handled under long-standing agreements), then, if unable to settle grievances against employers, would submit the case to a 15-man employer-union board which would have authority to make binding decisions. No strikes or work stoppages would be permitted during the course of these proceedings. Authority of the board would be legalized by provisions in future management-labor contracts.

(The 14-year-old National Joint Board for settlement of Jurisdictional Disputes in the Construction Industry is authorized to act in a somewhat similar manner in cases involving inter-union battles over jurisdiction).

Approved by AGC and by the top command of the Building Trades, the new agreement awaited only local union okay before going into effect. It would come not a moment too soon: Congress is about ready to take some heavy handed action against labor stoppages in construction because of numerous strikes on government construction projects, paritcularly missile bases.

* * *

On labor, there were two other developments of concern to water works men: The House labor committee began hearings on the several measures that would permit so-called "common situs" picketing at construction sites; and bills were introduced in both houses to change provisions of the Davis-Bacon Act so that "fringe benefits" would be included in prevailing wage determinations by the Labor department.

The last part of the paragraph above is important of course: Davis-Bacon applies only to projects in which Federal money is involved (thus a great deal of water and sewage work), and prevailing-wage determinations almost automatically set wage floors in most areas. Idea of the sponsors (California's Senator Kuchel and Rhode Island's Rep. Fogarty) is to force "outside" contractors to meet local wage and benefit agreements.

* * *

Although President Kennedy tucked his suggestion for a Department of Urban Affairs into the bottom of his omnibus message on housing, you still have to rate the chances against formation of such a department this year. Opposition is considerable, and it includes many big-city Congressmen as well as rural-area representatives, for reasons beyond the fact that Housing Administrator Robert Weaver would probably get the new cabinet post. Fact is, the new department would step across many traditional lines—including some functions of the Corps of Engineers and the Public Health Service. Indications now are that Kennedy will propose the new department in a forthcoming reorganization plan—not as a formal bill—and that Congress will disapprove.

* * *

Speaking of things tucked away in other legislation, there's a matter of great interest hidden in the President's proposal (not yet introduced because of a parliamentary bobble) for financing the national highway program: It would tap the Highway Trust Fund for money to relocate families displaced by road building. Point of interest: Families would have to be located not only in housing commensurate with what they left, but the location must be suitably provided with sewer service and water supply, must be near transit and shopping, and not further from where the occupants are employed.

* * *

Public Health Service has launched a new attempt to find physical and chemical techniques for removing residual materials in sewage treatment plant effluents with a $25,200 contract to Dow Chemical Co.'s Industrial Service Division at Cleveland. The company will study efficiency of specially prepared activated carbons to remove contaminants—as you know, a method applied to treat raw water, but not so far to sewage treatment processes.

* * *

Engineering organizations think very little of the idea of establishing a "National Science Academy" (along the lines of West Point or Annapolis). That was clear enough as New York's Rep. Victor Anfuso opened hearings on his own bill to establish such an academy. Gist of testimony by top engineering groups: Such an academy would bleed existing engineering schools of faculty and students, couldn't do as good a job as the existing schools are already doing. Best suggestion: give the money an academy would cost to the existing schools in the form of research grants.

* * *

The long drawn-out controversy over how to handle spawning fish at two proposed high dams on the Middle Snake River has brought to light some new thinking in Washington on the whole question. The thinking is that maybe the traditional construction of fish ladders or more elaborate structures to get fish over the dams is wrong and expensive—why wouldn't it be cheaper and simpler to create "ideal" spawning grounds at some other location in the river, where the fish would no longer have to cross the dams at all? At least one version of a bill providing for such a project has been prepared—but it hasn't reached Congress as yet and may not get there this year.

* * *

The Dow contract is the first of a series of six that will be awarded to school and industrial laboratories, which will include study of such methods as foam fractionation, freezing, gas hydration, adsorption. Overall, the contracts will form the core of a new advanced sewage treatment plant program for PHS' Division of Water Supply and Pollution Control—in line with previous calls for use of scientific techniques not now a part of pollution control research.

* * *

Atomic Energy Commission has now made available to state officials a set of criteria under which the states may assume regulatory control of certain radioactive materials, under terms of an amendment to the Atomic Energy Act last year. Takeover by states can include responsibility for rule-making, licensing, inspection, compliance and enforcement of regulations concerning handling radioactive materials of less than critical mass. In most states, any such takeover will mean new legislation and a model law worked out by the Council of State Governments, Public Health Service and AEC is available for local consideration. Most such state regulation, it's contemplated, will come under state health departments.

New York University College of Engineering Annual Report of the Research Division, 1960

The Engineering Research Division of New York University believes research is an integral part of the educational process, according to Harold K. Work, Associate Dean and Director, in the 1960 Annual Report of the Research Division. Faculty members of the College of Engineering play a fundamental part in the work of the Research Division, serving as project directors, research co-ordinators, and technical specialists in the Division's multi-disciplinary program.

This research activity, the report states, enriches the educational experience of the college's students since it enables faculty members to be practicing scientists and engineers, in close touch with developments and current problems in their fields of specialization.

Several studies dealing with sanitation, industrial wastes and health problems are under the direction of Adjunct Professor William T. Ingram. One of these is the establishment of a combination of collection and instrument facilities to serve the needs of a group of communities comprising a metropolitan region.

"Field investigations are in progress," according to the report, "to obtain data from which a series of variables may be arranged to produce an efficient combination of services. Air pollution and meteorological studies of the region are also in progress. The research when completed should provide metropolitan area communities with data that will allow more efficient and less costly approaches to a regional collection and disposal of refuse."

Professor Ingram, according to the report, continues a study of behavior of deep filter beds used to treat sewage at rates greater than those normally used for the filtration of water through rapid sand filters. Using controlled filtration principles developed at New York University, domestic sewage is introduced into deep filters at hydraulic rates three times those used for the treatment of water and at organic loading rates thirty times that used for the filtration of sewage. The plant operates without recirculation, and organic growth in the filter is controlled by the combination of nutrients from the waste and oxygen from a positive air supply. As filter behavior becomes better known and controls are established, it will be possible to load hydraulically and organically to achieve the desired degree of secondary treatment by filtration. Both municipalities and industry should find it profitable to add controlled filtration to their waste treatment processes.

Research is also being continued in such fields as meteorology and oceanography, geophysics, physics, mechanics of solids, structural engineering, metals, chemicals and chemical processes, special projects, engineering mathematics and electronics.

The report states that to date, more than 300 industrial concerns, government agencies, private engineering firms and foundations have utilized the scientific facilities and trained personnel of the Division, many of them continuing to use its services over the years. The year's expenditure for research reached a new high of $3,700,000 compared to $3,300,000 for last year. During the year, the professional and technical staff numbered 523, an increase of 48 over last year's figure.

Automation Operates Montclair, N.J., Plant Efficiently With Small Budget

Montclair, N. J. water department officials, like most municipal department heads today, were faced with the problem of operating their department with a tight budget. Water from the city's Wanaque Reservoir comes through a 74 in. steel aqueduct to supply three water service areas through two pumping stations. Both pumping stations in the system required constant supervision, with adequate personnel for each.

In order to operate more efficiently within their limited budget, they reviewed their existing situation and decided upon three objectives. These were: to automate completely one of the two pumping stations so that one set of personnel could operate both stations; to provide savings to pay for the equipment; and to do the remodeling job within the framework of an existing 30-year old pumping station.

Now, only one station (Watchung Avenue) is now manned. The second pumping station (Grove Street) is remotely controlled.

How was this accomplished? They eliminated the need for direct supervision by protecting the pumps automatically from overheating damage, and by effecting the remote transmission of all instrument measurements from unmanned Grove Street station to a supervisory control panel at Watchung.

Thus, Montclair water department officials have been able to effect an annual savings of $12,000 and meet all the above objectives.

A low-cost temperature monitoring system, Thomas A. Edison Industries Omniguard, provides the reliable heart of this automatic system. Motor bearing temperatures of each of the four pumping units at the remotely operated Grove Street station are monitored continuously. If the temperature of any one of the 16 monitored points exceeds a predetermined set point, the pump unit concerned is automatically shut down, thus preventing damage to expensive equipment. An audible alarm is also sounded at the supervisory station.

Additionally, the remote control panel at the Watchung supervisory station permits starting and stopping any of the four pump units for the Grove Street station, as well as control of the valves for each pump. The temperature monitoring system watches critical temperatures and pressures continuously (eliminating stepping switches, scanning devices, and amplifiers completely).

Four temperature detectors are directly connected to each monitor by ordinary copper wires. The detectors each form one leg of four simple Wheatstone bridge circuits in each monitor unit. Any deviation from normal pre-set temperature limits unbalances the bridge, causing relays to sound an alarm and to activate an alarm light on the face of the monitor panel. Moreover, the Grove Street installation alarm contacts are operated to automatically shut down the pumping units in the events of excessive bearing temperatures.

your customers
test your water daily
So should you!

AQUA
NUCHAR
ACTIVATED
CARBON
for taste and odor control

Even your best friends will tell you . . . *fast* . . . when your water tastes or smells bad.

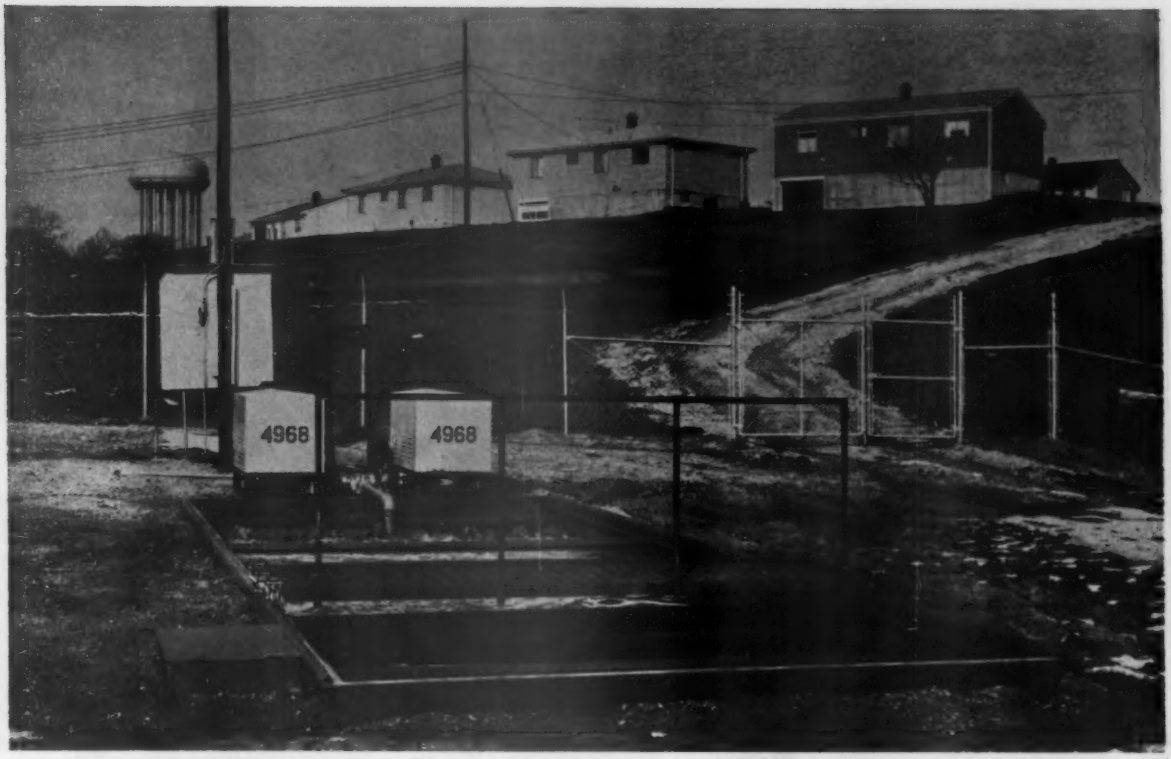
Best way to forestall complaints is with daily threshold odor tests to detect and accurately measure variations, then using AQUA NUCHAR in controlled amounts to meet these changing day-to-day needs thereby assuring *consistent palatability.*

AQUA NUCHAR adsorbs tastes and odors due to algae, decaying vegetation, trade wastes and other causes. Where adequate feed capacity is available, it is the only method proved universally effective. And it is economical, too, since only a few ppm average concentrations do an effective job.

Our field technical staff is available to survey your plant and advise on your requirements.

West Virginia Pulp and Paper
INDUSTRIAL CHEMICAL SALES DIVISION

230 Park Ave., New York 17 · Philadelphia National Bank Bldg., Philadelphia 7 · 35 E. Wacker Dr., Chicago 1 · 2775 S. Moreland Blvd., Cleveland 20



Kansas City North

This 17,500-gallon-per-day "Oxigest" sewage treatment plant is equipped with two motor-driven blowers with variable speeds for control of the air supply and has a movable walkway across the tank for ready access to all parts of the treatment plant.

S&L *ACTUALLY*, this is a dual "Oxigest" installation in Kansas City North, Mo., serving a growing subdivision being developed by Bolling-Hausman Development Co., Kansas City, Mo. The plant was specified by Raymond W. Campbell & Associates, Merriam, Kansas.

It is a good example of units being installed in parallel, as needed, to serve an expanding residential area. The unit on the left was installed in the spring of 1960 . . . the other unit, late last fall.

Write for engineering data: Address Department 20.

Smith & Loveless

ONE OF THE UNION TANK CAR COMPANIES

P. O. BOX 8884/KANSAS CITY 15, MISSOURI/PLANT: LENEXA, KANSAS

(2840)

P. H. Van Orden, President, C. L. Peterson, Vice-President and Treasurer, and R. H. Webb, Foreman of the Van Orden Company, Contractors, of Grand Rapids, Mich., supervise the installation of "K&M"® Asbestos-Cement Sewer Pipe at Paw Paw, Mich.

10,000 FT. OF SEWER PIPE LAID...

. . . not enough infiltration to measure

Read how the Van Orden Company solved the problems of installation and of infiltration when pipe had to be laid 9 ft. below the water table.

"the ease of handling and assembly saved us dollars and time!"

P. H. Van Orden

"Construction of the Paw Paw trunk sanitary sewer called for installation of pipe at depths up to 19 feet, where water table was at 10 feet. Infiltration had been the major problem in other sewer installations in the area. We solved this problem by using "K&M" Asbestos-Cement Sewer Pipe with its FLUID-TITE joint. With 10,000 feet of sewer in, we haven't had enough infiltration to measure.

"The longer laying lengths and the speed with which a joint can be made are definite time-saving factors, which have added to our production. Less time spent grading pipe and handling material means dollars saved."

Rigorous tests prove "K&M" Asbestos-Cement Sewer Pipe is infiltration-tight at 25 psi . . . a pressure equivalent to that of a 58-foot head of water.

"K&M" Asbestos-Cement Sewer Pipe wont rust, rot, or corrode. Its smooth bore remains clean, permanently. Flatter grades are possible. Fewer lift stations are required.

Maintenance-wise, the village of Paw Paw, Mich., will enjoy tax savings. "K&M" Asbestos-Cement Sewer Pipe is practically indestructible. Requires fewer inspections, because root growths do not penetrate the exclusive FLUID-TITE coupling.

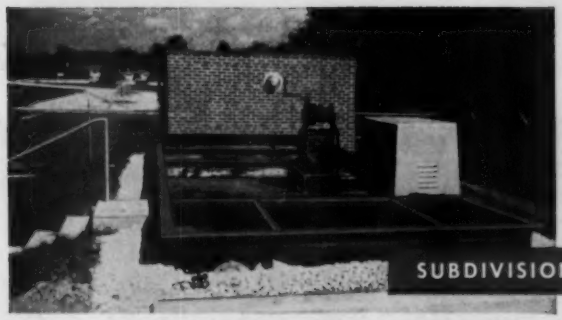
Write today for more information on "K&M" Asbestos-Cement Sewer Pipe to: Keasbey & Mattison Company, Ambler, Pa.

Keasbey & Mattison at Ambler

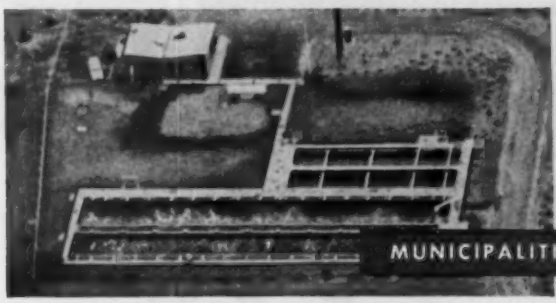
K·M BEST IN ASBESTOS

Two-step assembly! Lubricate the tapered end of "K&M" Asbestos-Cement Sewer Pipe, then slide it into the exclusive, patented "K&M" FLUID-TITE® Coupling.

Light weight reduces shipping and handling costs...saves on installation time. At the same time, there's a minimum of wastage and breakage on the job, with tough "K&M" Asbestos Sewer Pipe.

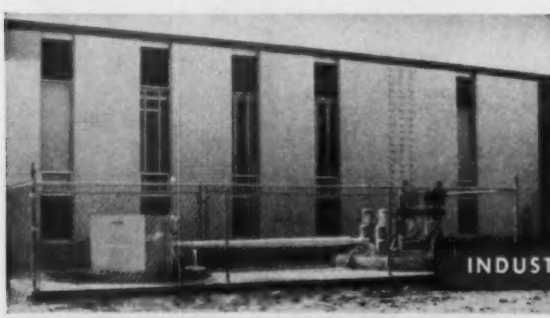


RAMS . . . Indianapolis, Indiana . . . RatedAeration, medium steel sewage treatment plant for design flows to 15,000 GPD. Factory fabricated with "Chicago" standardized balanced equipment. Engineer— Lennox, Mathews, Simons & Ford. Bulletin 135-A.



RALC . . . Vacaville, California . . . Large concrete RatedAeration plant using "Chicago" sewage equipment throughout for more effective treatment. Capacities from 60,000 GPD. Engineer— M. Carlton Yoder. Ask for Bulletin 135-A.

RAMC . . . Hialeah, Florida . . . Above ground installation of a medium concrete treatment plant. Packaged standardized, balanced equipment for flows from 7,500 to 60,000 GPD. Engineer— Loyd Frank Vann Associates. Ask for Bulletin 135-A.



RASS . . . Meterie, Louisiana . . . Small steel, circular factory fabricated sewage treatment plant for communities from 10 to 500 people available in 1, 3, & 5,000 GPD capacities. Engineer —Curtis & Davis. Ask for Bulletin 136.

©1961—CP-FMC

"from Chicago"

RATEDAERATION SEWAGE TREATMENT EQUIPMENT FOR EVERY FRINGE AREA SEWAGE NEED

Odor free, nuisance free, low cost, small package steel or large concrete plants . . . 1,000 to 1,000,000 GPD

Whether steel or concrete units, *all* RATEDAERATION systems obtain the same degree of high treatment through aeration. Proved successful in more than 950 installations, RATEDAERATION units are always economically expandable for area planning of future sewage systems.

There is a small packaged RATEDAERATION unit specifically designed to provide any fringe area with reliable, continuous sewage treatment at low original cost . . . and with low operating expense.

For further information call your local Chicago Pump distributor or write Chicago Pump for bulletins listed above.

fmc
FOOD MACHINERY AND CHEMICAL CORPORATION

Putting Ideas to Work

FOOD MACHINERY AND CHEMICAL CORPORATION
HYDRODYNAMICS DIVISION

CHICAGO PUMP

622H DIVERSEY PARKWAY • CHICAGO 14, ILLINOIS

FLUIDICS* AT WORK

How to increase aeration capacity without adding new tankage

Here is the new activated sludge system at York, Pa. Sewer Authority. Plant capacity is higher than ever before, yet not a cent has been spent for new basins.

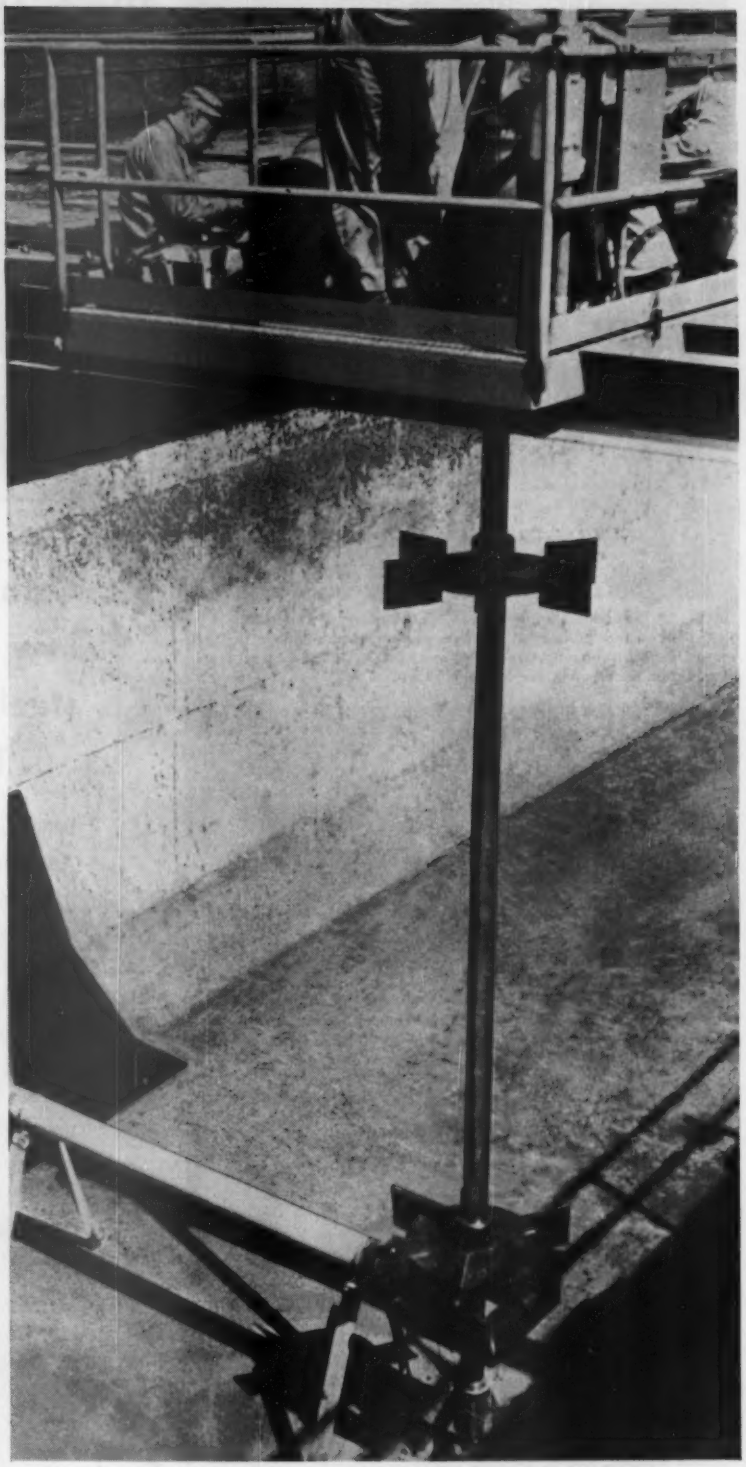
Four Permutit® Permaerators make up the heart of the system. The unit you see being installed is capable of transferring 115 lb. of oxygen per hour with a compressed air flow of only 420 cfm.

High efficiencies of this type are possible by utilizing atmospheric air entrained by the upper turbine of the Permaerator. In addition, the upper turbine redisperses compressed air released from a sparge ring beneath the lower turbine.

Albright & Friel, the consulting engineers, recommended Permutit Permaerators because of their high efficiency, rugged construction, and low initial cost. By the installation of four Permaerators, the system's ability to handle higher hydraulic and biological loadings was significantly increased. Since Permaerators are adaptable to old as well as new basins, this increase in treatment capacity was achieved without construction of any additional tankage.

What York has done, you too can accomplish. If you need to increase the capacity of your activated sludge plant with a minimum of capital expenditure, consider the Permutit Permaerator. For further information, write for Bulletin 4619. Permutit Division, Dept. WS-51, 50 W. 44th Street, New York 36, N. Y.

*FLUIDICS is the Pfaudler Permutit program that integrates knowledge, equipment and experience in solving problems involving fluids.



Twin-turbined unit being installed here is one of four Permutit Permaerators now in use at York, Pa.—one in each of two aeration tanks, and two in the return sludge stabilization tank.

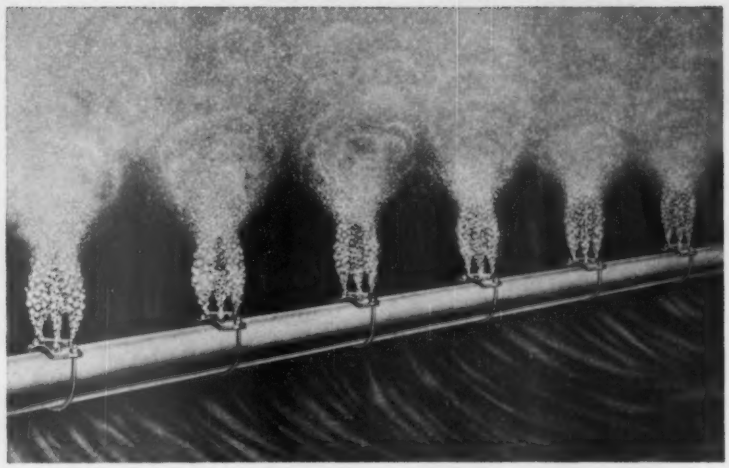
PFAUDLER PERMUTIT INC.
Specialists in FLUIDICS . . . the science of fluid processes

GAMON METER DIVISION

NEWARK NEW JERSEY

WORTHINGTON

efficient oxygenation
DIFFUSAIR *SPARJERS*



Jack-knife Headers
— for easy inspection

Self-cleaning Metering Orifices
— for uniform, clog-proof operation

Clustered Orifice Diffusion
— for controlled turbulence and intra-floc oxygenation

Diffusair SPARJERS combine controlled air bubble release with increased tank turbulence and circulation velocities to provide the most efficient oxygenation media available. In developing the SPARJER, Walker Process Engineers thoroughly investigated all factors involved in the complex process of aeration and oxygenation. As a result the thousands of SPARJERS installed in hundreds of installations during the past decade feature high O_2 absorption, no back pressure build-up to impair blower performance and low cost operation.

JACK-KNIFE pivotal headers are offered by Walker Process to provide a convenient and economical method of installing SPARJERS without extensive on-the-job pipe work. Walker Process JACK-KNIFE headers include extra heavy swivel joints that will not bind or freeze and an exclusive hydraulic hoisting mechanism. This rugged but simple lifting assembly is easily handled by one man.

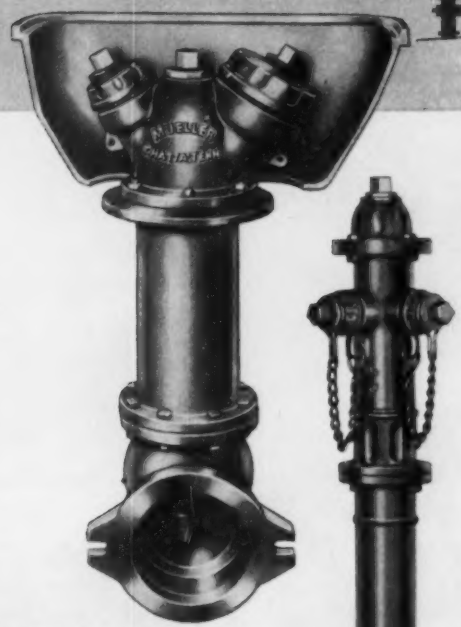
Write factory at P.O. Box 266, Aurora, Ill. for equipment recommendations and details for your aeration project. Also, ask for bulletin 22-S-96 describing the new PLATETUBE porous diffusers.

WALKER PROCESS EQUIPMENT INC. AURORA, ILLINOIS

a leader in equipment for . . .

SEWAGE TREATMENT • WATER TREATMENT • INDUSTRIAL WASTE TREATMENT

for that specialized application...



MUELLER®
Fire Hydrants

Built with the same care and quality as the Mueller AWWA Standard Fire Hydrants for municipal use, these Mueller Fire Hydrants for special applications have exactly the same design features, too:

- Compression-type main valve that provides positive closures is always ready for use.
- Automatic drain valve that is flushed clean with every operation, empties barrel completely to prevent freezing.
- O-ring that assures positive, leak-proof seal requires no maintenance.

Standardize on the quality and features of Mueller fire hydrants for municipal, industrial, commercial and private fire protection systems.

FLUSH TYPE

For use at airports, on narrow streets or sidewalks and in other areas where post type hydrants are impractical.

AWWA 4¼" or 5¼" valve opening two-way or three-way

2½" valve opening . . .one-way

POST TYPE

for use on private estates, at country clubs, in parks, for dead-end flushing and wherever smaller amounts of water are sufficient.

2½" valve opening
. . . one-way or two-way

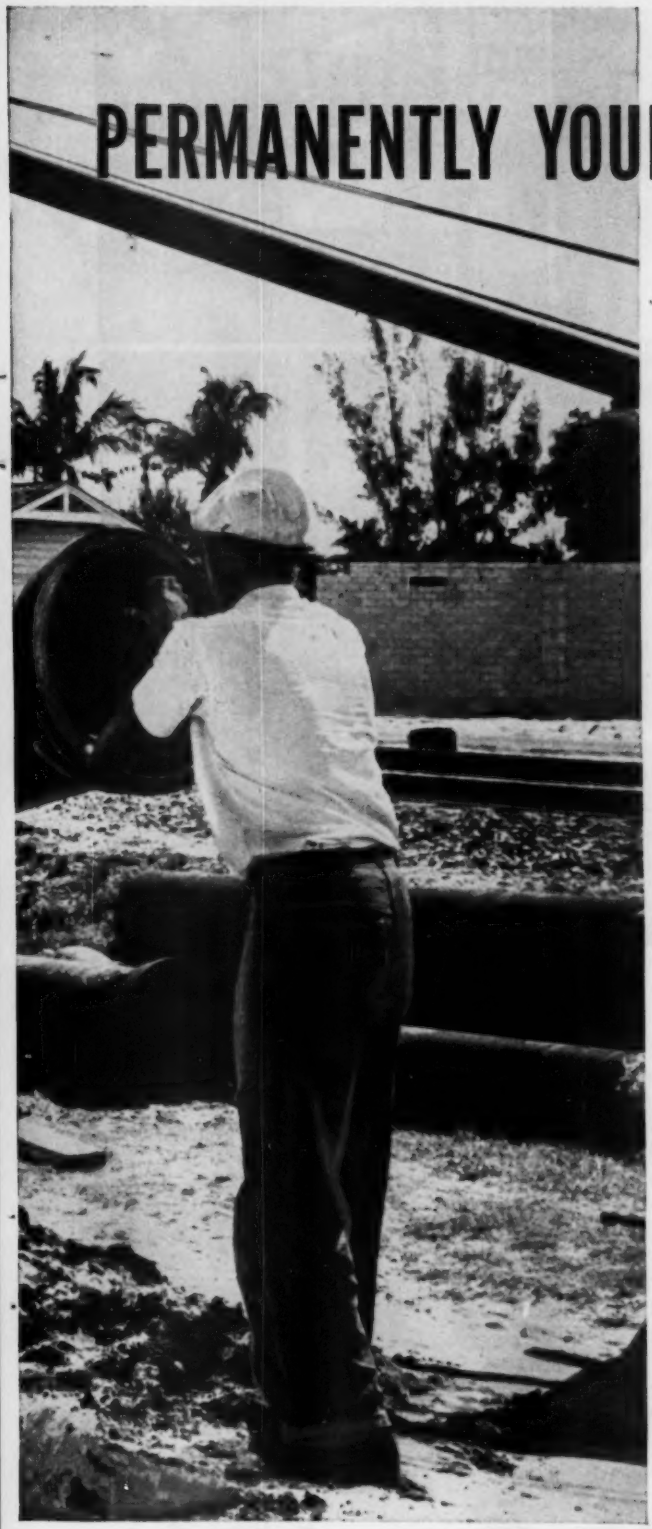
Write for complete information and specifications.

MUELLER CO.
DECATUR, ILL.

Factories at: Decatur, Chattanooga, Los Angeles
In Canada: Mueller, Limited, Sarnia, Ontario

5892

THE MARK OF THE 100-YEAR PIPE



PERMANENTLY YOURS: CAST IRON PIPE

Installed... it stays installed

One thing sure about cast iron pipe—once it's in the ground, it's there for keeps! Over 100 American utilities, having used cast iron pipe steadily for more than a century, can testify to that. And *modern* cast iron pipe gives you greater assurance than ever: great beam strength resists heavy surface traffic; tremendous load resistance absorbs even the most forceful pressures. In fact, when you select cast iron pipe, you can anticipate no major repairs in your water supply system for the next hundred years!

Cement-lined—it stays cement-lined

A smooth coat of cement lining along the inner wall helps prevent the formation of flow-reducing particles. No matter how strong the water is, cast iron pipe always assures a free, steady flow.

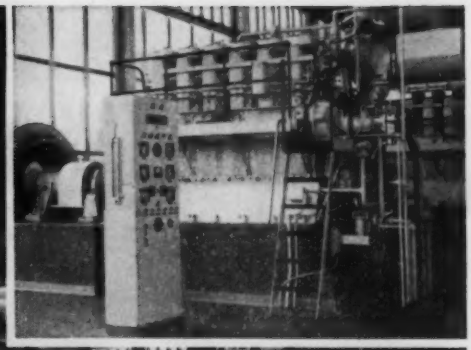
Joined—it stays joined

Bottle-tight, rubber-ring joints give you leak-proof protection at the most vulnerable points of your system. Vibrations, surface traffic and washouts present no problem to cast iron pipe. Inherent ruggedness . . . built to perform under all adverse underground conditions . . . repair-free service for at least a century—all good reasons why your choice should be that of water utility experts everywhere. America's greatest water carrier: cast iron pipe.

Cast Iron Pipe Research Association, Thos. F. Wolfe, Managing Director, 3440 Prudential Plaza, Chicago 1, Illinois

CAST IRON PIPE

TOLEDO SEWAGE PLANT
Handles up to 135 Million Gals. per day

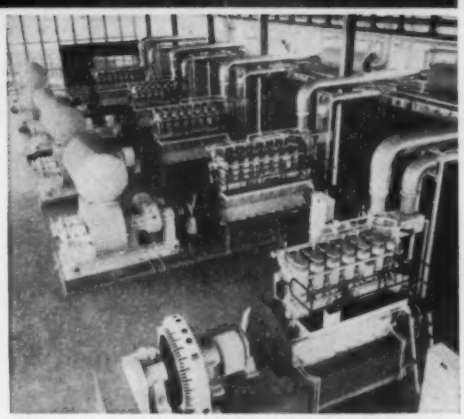


with ENTERPRISE Tri-fuel Engines

Design and Construction by Consoer, Townsend & Associates, Chicago.

Main sources of power and processed air in the modern, highly efficient Sewage Plant of the City of Toledo, Ohio are five Enterprise turbo-charged, tri-fuel engines. These versatile heavy duty engines operate on diesel fuel, dual fuel, or spark ignition. The switch from straight diesel fuel to pilot-injection sewage gas operation is instantly accomplished by means of a lever control mounted on front of the engines. To switch to spark-ignition sewage gas operation requires only a minor change, in just a few hours' time. Annual savings through the use of sludge gas are estimated at around $50,000. Heat normally required for the plant and processes is provided from jacket water and waste heat mufflers with the engines in operation.

For low-cost, dependable power on municipal and industrial jobs, your next engines should be ENTERPRISE. Call us, or write for complete data and recommendations.



BOTTOM, Four Enterprise engines drive blowers for aeration process.

TOP, Fifth Enterprise engine drives a generator for stand-by power.

ENTERPRISE Diesels

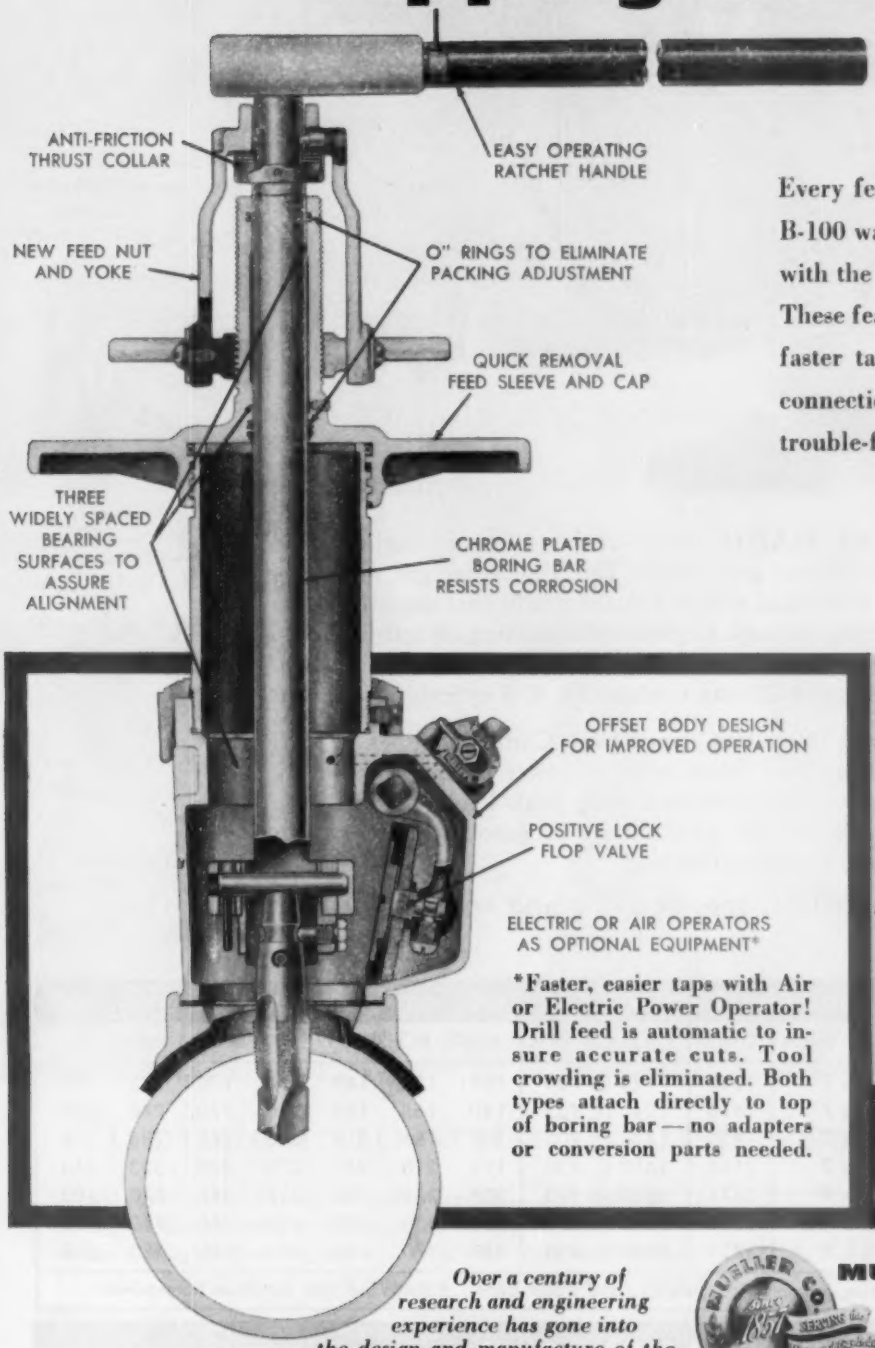
THE DEPENDABLE

A SUBSIDIARY OF TRANSAMERICA CORPORATION

Enterprise Engine & Machinery Co., Division of General Metals Corporation
550-85th Ave., Oakland 21, Calif. • 37-02 48th Ave., Long Island City 1, N.Y.
National and worldwide sales and service

operators like the ease . . .
the speed . . . the accuracy of the new

MUELLER® B-100 tapping machine!


ANTI-FRICTION THRUST COLLAR
EASY OPERATING RATCHET HANDLE
NEW FEED NUT AND YOKE
O" RINGS TO ELIMINATE PACKING ADJUSTMENT
QUICK REMOVAL FEED SLEEVE AND CAP
THREE WIDELY SPACED BEARING SURFACES TO ASSURE ALIGNMENT
CHROME PLATED BORING BAR RESISTS CORROSION
OFFSET BODY DESIGN FOR IMPROVED OPERATION
POSITIVE LOCK FLOP VALVE

Every feature of the new B-100 was designed with the operator in mind. These features give you faster taps, pressure-tight connections and easy, trouble-free operation.

ELECTRIC OR AIR OPERATORS AS OPTIONAL EQUIPMENT*

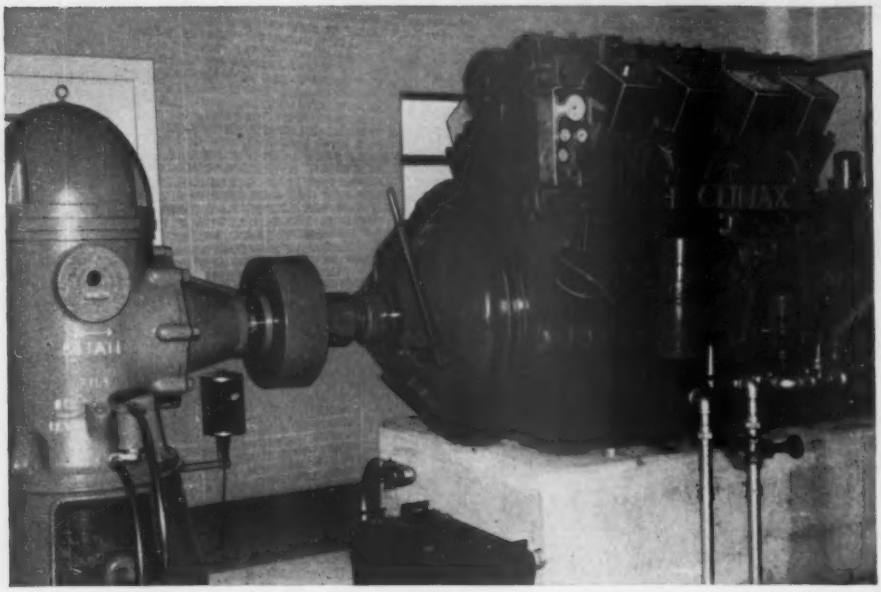
***Faster, easier taps with Air or Electric Power Operator! Drill feed is automatic to insure accurate cuts. Tool crowding is eliminated. Both types attach directly to top of boring bar — no adapters or conversion parts needed.**

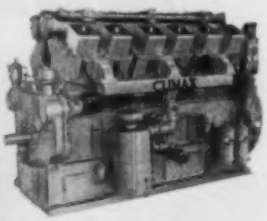
Over a century of research and engineering experience has gone into the design and manufacture of the B-100 Drilling, Tapping and Inserting Machine.

MUELLER CO.
DECATUR, ILL.

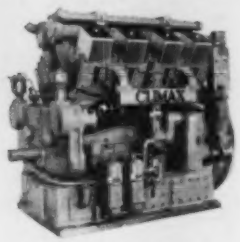
Factories at: Decatur, Chattanooga, Los Angeles; In Canada: Mueller, Limited, Sarnia, Ontario.

CLIMAX MUNICIPAL ENGINES

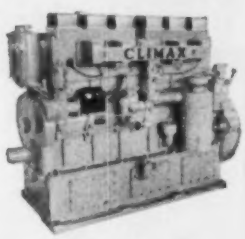




V-125—12 cylinder,
605 max. hp. at 1200 rpm.
V-122—12 cylinder,
520 max. hp. at 1200 rpm.



V-85—8 cylinder,
390 max. hp. at 1200 rpm.
V-80—8 cylinder,
340 max. hp. at 1200 rpm.



K-75—6 cylinder,
304 max. hp. at 1200 rpm.
K-67—6 cylinder,
265 max. hp. at 1200 rpm.

IN SEWAGE TREATMENT PLANTS everywhere Climax engines power sewage pumps, blowers and generators. Burning sludge gas, and utilizing heat from jacket water and engine exhaust gas to heat digesters and buildings, they effect big savings. Capable of operation on natural gas, butane, gasoline, or any combination. For continuous duty service in sewage plants—seven rugged Climax models: 12, 8, 6 cylinders.

IN WATER WORKS over 100 cities depend on Climax engines... for prime power, or to take over when normal power for pumps is interrupted or fails... and to drive pumps during peak loads as supplementary power. Burning natural gas, butane or gasoline Climax Water Works engines range in size to 600 hp.

Write direct for bulletins, specifications and engineering consultation.

CL-106-R

BASIC MAX. ENGINE HP (Natural Gas and Gasoline) ①					600	700	800	900	1000	1100	1200
MODEL	No. of Cyls.	Bore and Stroke	Displ.	Torque @ RPM	BRAKE HORSEPOWER AT SPEEDS INDICATED						
R-165	6	6⅛ x 7	1238	930 @ 750	105	123	140	156	170	183	192
K-67	6	7 x 7	1616	1240 @ 805	140	165	188	210	230	248	265
K-75	6	7½ x 7	1855	1410 @ 800	160	186	214	240	265	286	304
V-80	8	7 x 7	2155	1610 @ 850	178	210	241	272	300	323	340
V-85	8	7½ x 7	2474	1860 @ 900	207	249	285	317	345	370	390
V-122	12	7 x 7	3232	2440 @ 900	280	330	380	420	460	490	520
V-125	12	7½ x 7	3711	2880 @ 850	310	370	435	490	540	580	605

① Basic engine includes ignition, maximum carburetion, and water pump. Ratings indicate maximum horsepower.

CLIMAX ENGINE MANUFACTURING CO. • FACTORY—CLINTON, IOWA
DIVISION OF WAUKESHA MOTOR COMPANY

"I ended up with 'do-it-myself' service...

...did I get taken! I plead for pump service — and find out I'm talking to the salesman's telephone answering service. 'He's out in the territory,' they tell me . . . 'won't be back until Friday.' *Territory,* indeed! What am I supposed to do, organize a bucket brigade until Friday? Why can't that manufacturer hire someone to *service* pumps! Someone who fixes 'em for a living — not a salesman who just does service as a sideline."

Trained service at your command . . . one of the benefits of dealing with Allis-Chalmers. Industrial Equipment Division, **Allis-Chalmers,** *Milwaukee 1, Wisconsin.* A-1477

ALLIS-CHALMERS GIVES TRAINED SERVICE

At Allis-Chalmers, the servicemen "service" and the salesmen sell. Every regional office has available a network of specifically factory-trained men to service pumps "on the spot." Certified Service Shops can rebuild equipment quickly . . . save you transportation expense and time. When you call for service, you get service . . . from servicemen. The quickest and best offered by any pump manufacturer.

Hardly! You see, Transite®, the *white sewer pipe*, is made of ageless minerals—asbestos and cement. The asbestos fibers, each with the tensile strength of piano wire, reinforce the cement to form a stone-like pipe that is rugged, tough and durable. Transite is also steam-cured under high pressure, adding further to its strength, durability and chemical stability. And, being non-metallic, there's no chance of oxidation weakening its structure. What's more, Transite's high crushing strength can withstand the heavy overburden, ground movement and earth shocks that continually challenge the ability of sewer pipe. When you add to this Transite's long lengths, tight joints and naturally smooth interior, it becomes obvious that this white sewer pipe was designed to offer greater total life expectancy.

For all the facts, write for special data file. Please indicate if you are a city official, engineer or contractor. Address: Johns-Manville, Special Sewer Data, Box 14, WS-4, New York 16, N. Y. In Canada: Port Credit, Ont. Cable address: Johnmanvil.

The Transite Pipe shown in this 23-year-old photo is still providing trouble-free service.

JOHNS-MANVILLE
TRANSITE SEWER PIPE

Like any original . . . it cannot be duplicated!

Regardless of claims, *there's only one* TARSET® . . . the *original* coal tar-epoxy resin coating. No other coal tar-epoxy resin coating duplicates the TARSET formula, and it has not been made available to any other coating manufacturer. No other coal tar-epoxy coating combines the proven adhesion characteristics, chemical resistance and low moisture absorption properties of coal tar pitch with the hardness, ruggedness and chemical resistance characteristics of epoxy resins, like Pitt Chem TARSET.

Here are a few advantages of TARSET over other coatings of its type:

1. **Only TARSET is backed with a six-year service record.**
2. **Only TARSET has established so outstanding a performance record.**
3. **Only TARSET is approved by governmental and industrial agencies.**

If you have a corrosion problem that seems unsolvable, investigate TARSET's proven advantages. Contact your nearest Pitt Chem Industrial Distributor . . . he's listed in the "Yellow Pages."

3279

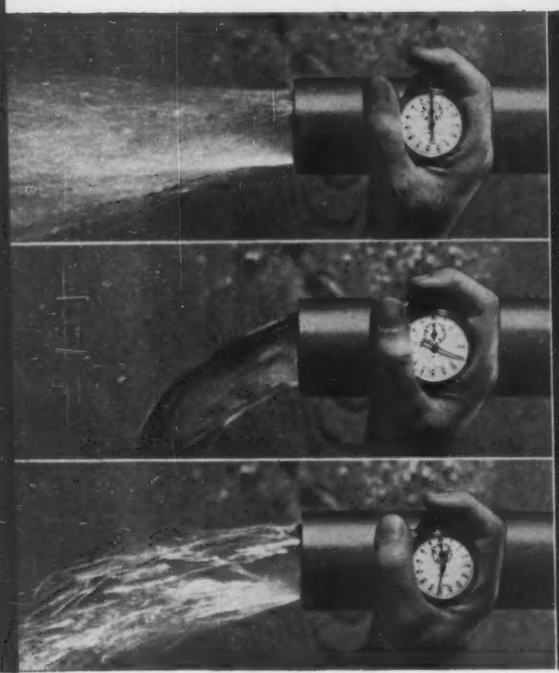
PROTECTIVE COATINGS DIVISION

PITTSBURGH CHEMICAL CO.

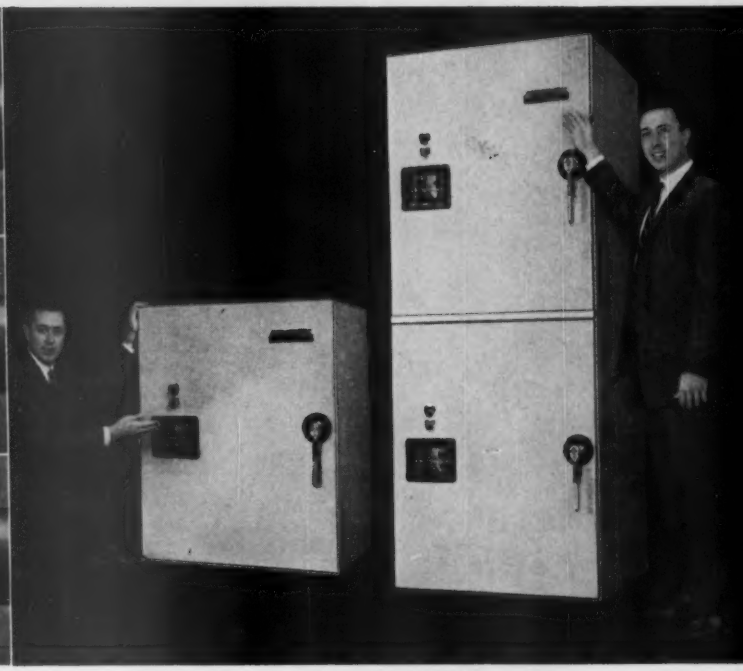
GRANT BUILDING PITTSBURGH 19, PA.

A Subsidiary of PITTSBURGH COKE & CHEMICAL CO.

ideas and news:



ACAP pump regulates flow instantly . . . without valves or varying pump speed. Proven ACAP (Adjustable Capacity, Adjustable Pressure) principle with internal pneumatic control automatically matches flow to demand. Regulation of flow through changing impeller clearances eliminates binding, plugging, saves power, allows system to operate at high efficiency regardless of demand.



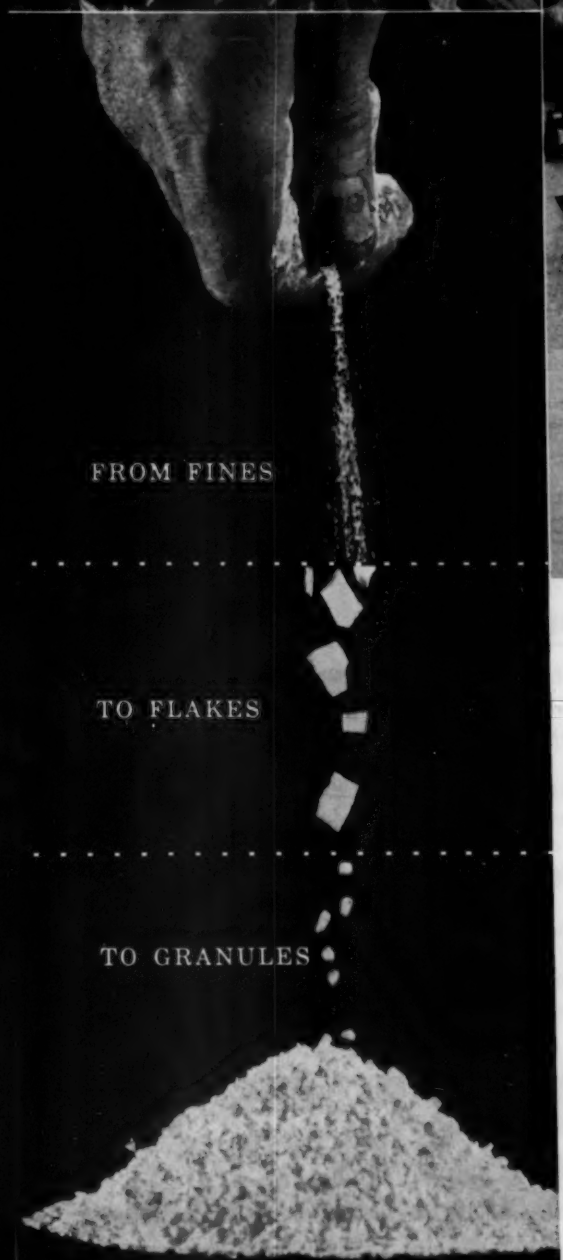
So low, two fit where one used to go: This new SpaceMaker control center is the first completely new 2- to 5-kv motor controller development in more than a decade. New compact two-high design can cut floor space requirements in half. Complete drawout construction makes it the safest, most easily accessible controller on the market. New flame-retardent, track-resistant Super Pyro-Shield insulation adds to reliability, reduces size and weight. And, the all-new roll-out contactor has been designed specifically to cut maintenance time and costs.

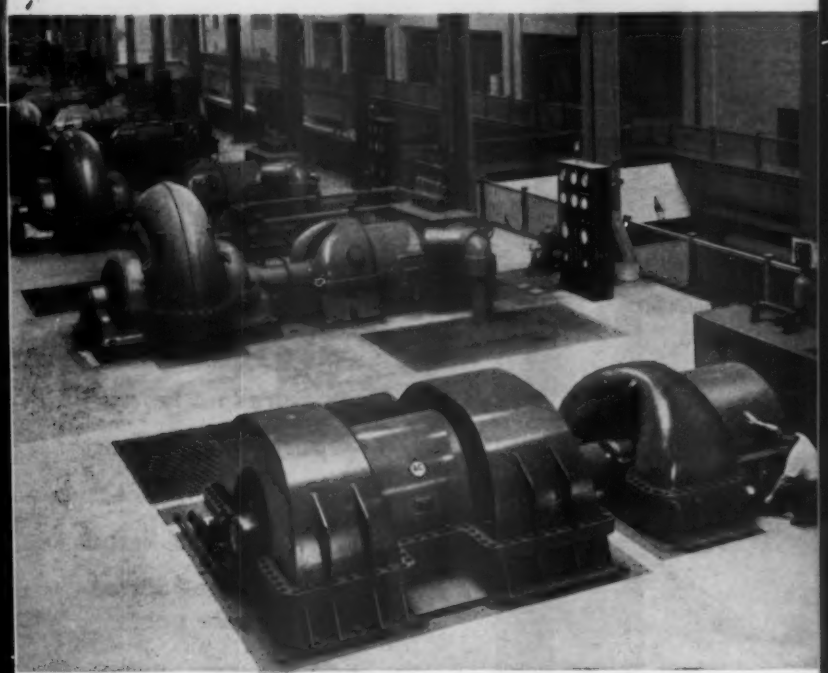
Which of these productive ideas could be working for you?

A pump that adjusts automatically. A high-voltage motor control center. These examples demonstrate the extra value that is a standard with A-C . . . the greater efficiency and the added productivity which are yours when you buy A-C products, systems and services. Call your Allis-Chalmers representative for details on A-C "worth-more" features. Or write Allis-Chalmers, Industrial Equipment Division, 904 S. 70th Street, Milwaukee, Wisconsin.

New coil insulation means fast service: Here's downtime insurance you'll probably never need. The Silco-Flex insulation system on large A-C motors is so superior that coil failure is highly unlikely in ordinary service. Should failure occur, the usual 10-day rewind shouldn't be necessary. Usually eight hours should be enough for the entire job of replacing the coil.

Up to 15% greater compressor efficiency: Giving near constant capacity over a large variable discharge pressure range at high efficiencies, A-C axial compressors like this one . . . the first to be used for sewage aeration . . . are ideal base-load machines. They are up to half the size, one quarter less weight, 8% to 15% more efficient than comparable centrifugal compressors.





Fines from heat-dried sludge made useable: Heat drying of sewage sludge creates fines which fertilizer companies cannot use. An Allis-Chalmers continuous compacting process is now upgrading these fines at a large eastern city to make them saleable. Fines are formed into solid sheets, then broken into granules, then separated and sized for sale to a commercial fertilizer manufacturer.

A-C INDUSTRIAL EQUIPMENT DIVISION: motors, control, rectifiers, pumps, compressors, crushers, mills, screens, kilns, industrial systems.

OTHER A-C PRODUCTS: thermal, hydro and atomic electrical generating equipment; switchgear, transformers, unit substations; tractors, earth-moving equipment, engines, lift trucks.

A-1398

SpaceMaker, Pyro-Shield, Silco-Flex and ACAP are Allis-Chalmers trademarks.

ALLIS-CHALMERS

EDDY New Improved Products Meet Modern Needs

EDDY Fire Hydrant

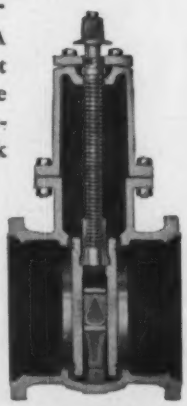
- Improved, streamlined, modernized
- Optional break-flange
- Large diameter barrel
- New self-sealing main valve packing
- Requires no lubrication
- Opens *with* pressure
- Closes *against* pressure
- Underwriters' listed
- Standardized, interchangeable parts

EDDY Check Valves

Completely new designs of horizontal swing check valves are available in sizes from 4 through 12 inches. They operate dependably in either vertical or horizontal positions and incorporate construction features which provide unusual flexibility of operation. These valves may be converted in the field from plain to single- or double-lever operation to meet changing requirements. Other check valves up to 24 inches.

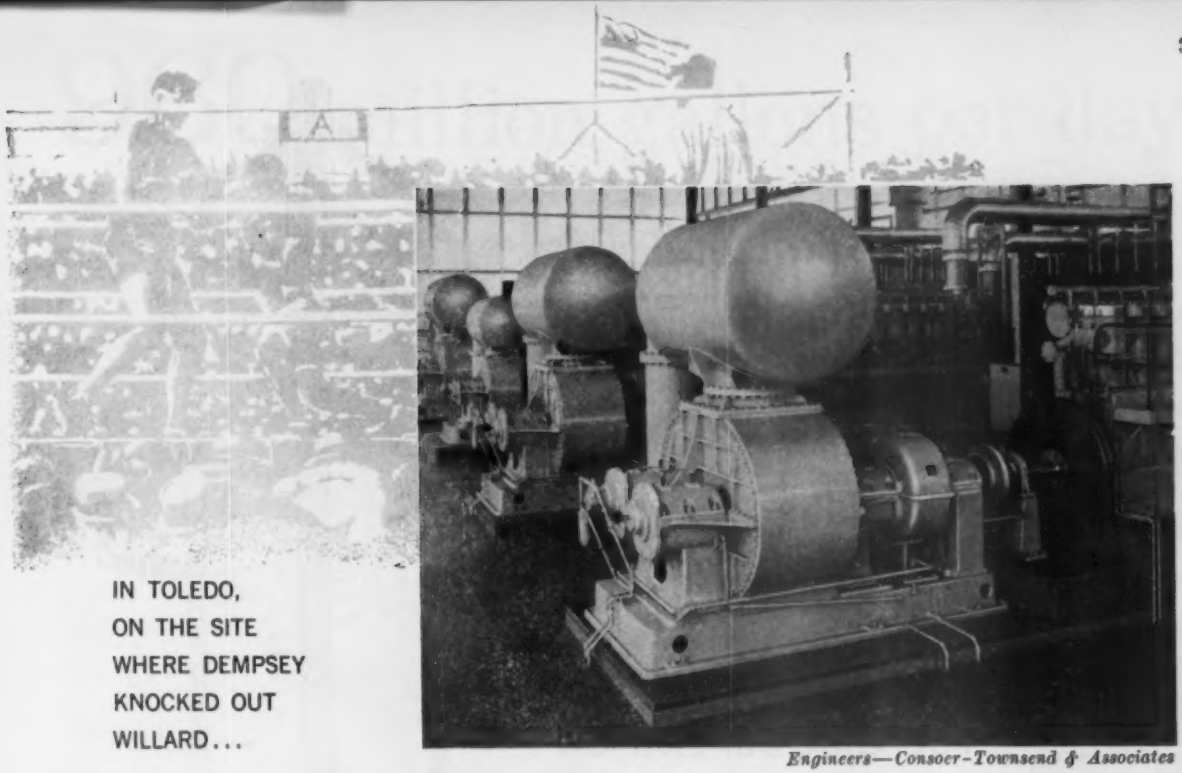
EDDY Gate Valves

In addition to the regular line of EDDY Taper Seat AWWA gate valves, EDDY now offers a newly designed parallel seat AWWA gate valve in sizes through 12 inches. This valve has been specifically engineered to provide long, trouble-free service. Working parts are designed with heavy, thick section and large seating surfaces for dependable operation and improved wearing qualities. The valve has two-point, free-floating wedging for minimum friction and maximum operating ease. Other AWWA gate valves are available through 48 inches.



Whatever your waterworks requirements, it will pay you to have full information on the complete EDDY *line of valves and hydrants.*

EDDY VALVE COMPANY
A Subsidiary of James B. Clow & Sons, Inc.
WATERFORD NEW YORK



IN TOLEDO,
ON THE SITE
WHERE DEMPSEY
KNOCKED OUT
WILLARD...

Engineers—Consoer-Townsend & Associates

ROOTS AERATION BLOWERS

PROVIDE THE "KNOCK-OUT" IN SEWAGE TREATMENT

Roots-Connersville equipment in the heart of the outstanding Toledo installation includes four large rotary blowers driven by Enterprise trifuel diesel engines and one Electric Machinery synchronous motor-driven blower. The Roots blowers supply a total of 80,000 cfm of air at 4 to 8 psi. Infinite control of the volume of air delivered to the aeration tanks is achieved through the use of multiple units which can also be operated at variable speeds.

Roots rotary blowers adapt uniquely to the Kraus process utilized in the Toledo Sewage Treatment Plant. The same blowers are capable of supplying the four pound (high level) or the eight pound (low level) aeration systems. The "load following" characteristic of rotary positive displacement blowers results in power savings and minimum operating costs.

Design advantages of the Roots blowers selected for the Toledo plant include:

- SPEEDS—*conservative operating speeds contribute to quiet operation, low maintenance and long service life.*
- OPERATING ECONOMY—*horsepower requirements determined by actual operating pressure.*
- DRIVE FLEXIBILITY—*may be direct-coupled, belt-driven or geared to engines or electric motors.*
- CAPACITY RANGE—*wide selection of sizes up to 25,000 cfm for pressures to 10 psi.*
- CONSTANT VOLUME — *constant volume delivered regardless of temperature or pressure requirements.*
- EFFICIENCY — *high volumetric efficiency assured with minimum slippage.*

Additional data about Roots-Connersville equipment appear in Chemical Engineering Catalog and The Sewerage Manual. For design information and specification data covering Roots rotary or centrifugal blowers, gas meters and vacuum pumps write or call your R-C Field Engineer, or write for the following bulletins: *Rotary blowers* . . . Bulletin RAS-158 or Bulletin RB-154; *Centrifugal blowers* . . . Bulletin 120-B-14; *Vacuum pumps* . . . Bulletin VP-158; *Gas meters* . . . Bulletin M-258.

ROOTS-CONNERSVILLE BLOWER
A DIVISION OF DRESSER INDUSTRIES, INC.
360 Mount Ave., Connersville, Indiana. In Canada—629 Adelaide St., W., Toronto

Darling B-50-B Hydrants are built for exceptional service

YOU CAN DEPEND ON

DARLING

Packless "O" ring seals (1) cut friction while assuring complete, permanent lubrication of operating mechanism. Ball bearings (2) reduce operating torque up to 50%. Direct-acting rod (3) operates the main valve and drain valve without auxiliary components.

An extra large barrel (4) delivers water at the nozzles without appreciable pressure loss. Multi-port draining (5) with positive flushing makes stoppage or freeze-ups virtually impossible . . . *you can depend on Darling.*

Darling B-50-B Hydrants are available in types and sizes for practically every installation. Write for Bulletin 5710.

DARLING VALVE & MANUFACTURING COMPANY
Williamsport 11, Pa.

The Canada Valve & Hydrant Co., Ltd., Brantford 7, Ontario, Canada
Vannes Darling-France, 23 rue du Commandant Mouchotte, St. Mandé, France

GATE • BUTTERFLY • CHECK • SPECIAL VALVES • FIRE HYDRANTS

960 million gallons per day!

Photo Courtesy Chicago Tribune

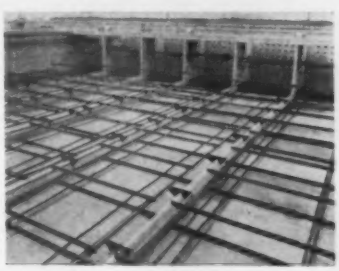
LINK-BELT Straightline sludge collectors at world's largest water filtration plant

Chicago Central-District Water Filtration Plant—Scheduled to begin service in 1962, it will boast a working capacity of 960 million gallons per day! The main structure alone measures more than 3300 feet long, 968 feet wide. Costs will run to some $102,000,000.

Sludge removal on this mammoth scale involves nearly 20 miles of Link-Belt chain (some 200,000 links!) . . . 144 longitudinal collectors . . . 16 cross collectors . . . 1248 collector sprockets . . . over 3700 redwood flights.

The high efficiency of Link-Belt *Straightline collectors* is reaffirmed continually in specifications for new waterworks construction. Sludge travels the shortest possible distance, at rates that assure minimum disturbance. Tank shape allows even flow distribution. And, no other collector matches Straightline's record for long life with minimum attention.

Whatever the scale you build on, large or small, look to Link-Belt for assistance in planning and equipping your water, sewage or waste-treatment facilities. Our sanitary engineering specialists will be glad to cooperate closely with you, your chemists and consultants. Call your nearest Link-Belt office for assistance *now*. 15.087



Link-Belt Type-H Straightline sludge collectors—similar to those being installed in the new Chicago Central-District Water Filtration Plant. Units shown here are actually part of the settling-tank system of the Queen Lane Water Filtration Plant in Philadelphia.

LINK-BELT

SANITARY ENGINEERING EQUIPMENT

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. Sanitary Engineering Regional Office—Atlanta, Chicago 9, Colmar, Pa., Kansas City 8, Mo., San Francisco 24. District Sales Offices in All Principal Cities. Export Office, New York 7. Representatives Throughout the World.

See our exhibit, A.W.W.A. Convention, Detroit, June 4-9.

Canton Job Moves Fast With Easy-To-Lay Concrete Pressure Pipe

In large photo at right, backhoe has dug trench and is lowering pipe into position.

Here workman lubricates rubber gasket for easy-to-make, bottle-tight joint.

Joint is made and crew checks position with alignment square.

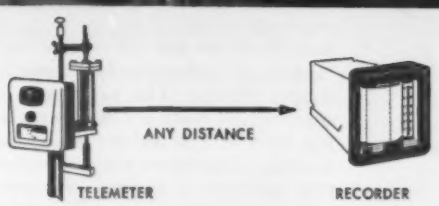
Workman pours grout to finish up joint as crew moves ahead with additional sections.

This 17-mile line runs from the new Sugar Creek treatment plant southwest of Canton. The pre-stressed concrete steel cylinder pipe is mostly 42-inch, with some 36-inch. It is the kind of pipe you "bury and forget," requiring little or no maintenance. The Superintendent of Water at Canton is Alfred E. Ransom. Beiswenger, Hoch & Associates were the consulting engineers. The pipe was manufactured by Price Brothers Company with headquarters plants in Hattiesburg, Mississippi and Dayton, Ohio.

Price Brothers
CONCRETE PRESSURE PIPE

BIF FIRST . . . IN MEASUREMENT AND CONTROL OF MATERIALS FLOW

*Where others fail... **B-I-F** time-duration telemetering is infallible!*

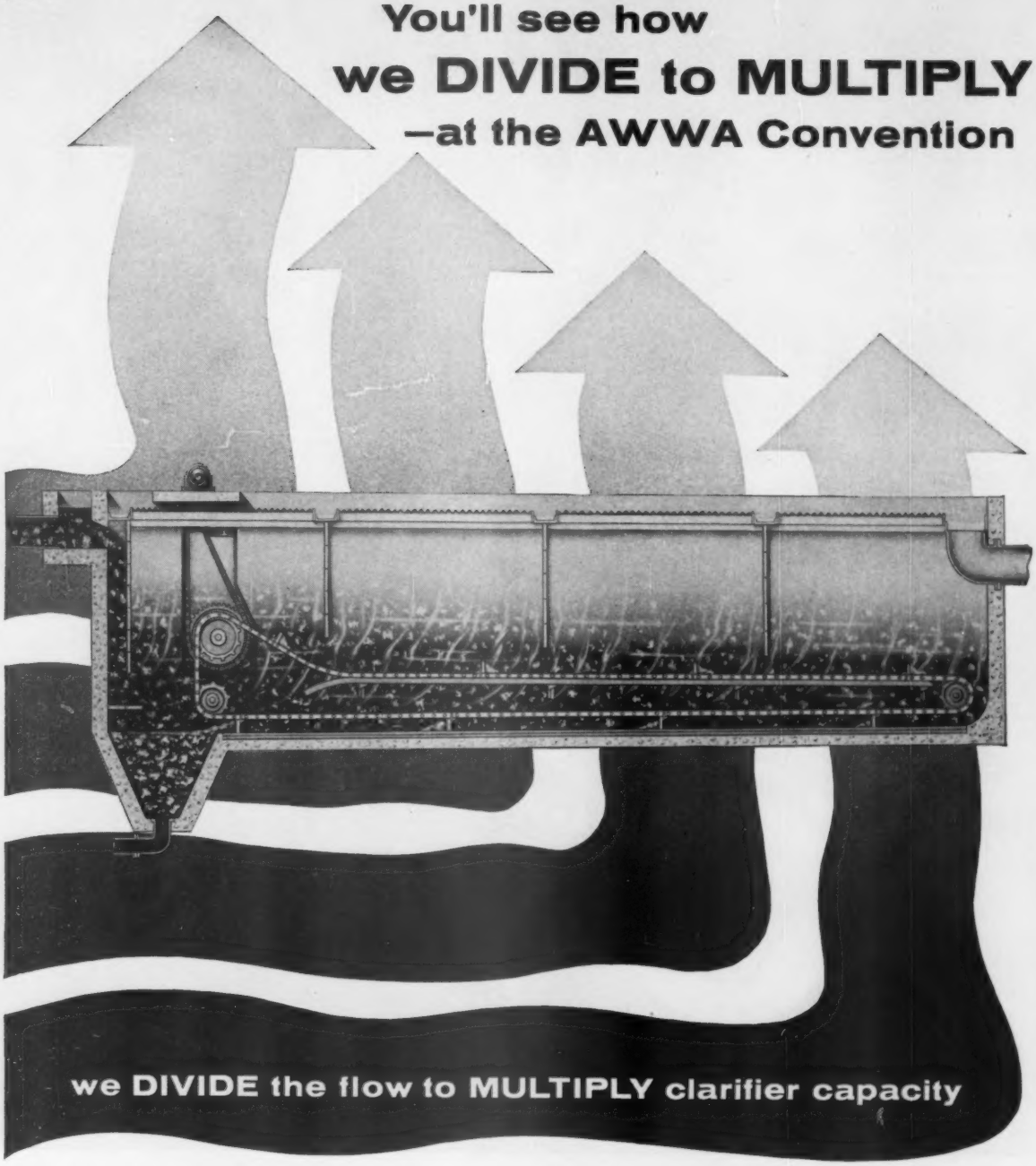


Miles apart . . . pressure drops, a flow rate changes, a pump fails, a valve sticks . . . all must be instantly, dependably recorded at one central data-gathering station. As infallible as time itself . . . normal variations in line voltages, resistance, inductance, or ambient temperatures do not affect the B-I-F system. Power loss doesn't call for readjustment. Physical quantities are measured in their own terms . . . response is faster . . . need for elaborate off-normal alarm equipment is eliminated . . . all at great savings in cost! From the simplest tank level recording to complex central data handling, B-I-F has the know-how and experience in telemetering and remote control to help you operate more efficiently. Compare B-I-F Chronoflo Telemetering with any other. Request Bulletin 230.20-2 for complete details. Write B-I-F Industries, Inc., 350 Harris Avenue, Providence 1, Rhode Island.

B-I-F **Industries**

BUILDERS-PROVIDENCE • PROPORTIONEERS • OMEGA METERS • FEEDERS • CONTROLS / CONTINUOUS PROCESS ENGINEERING

You'll see how
we DIVIDE to MULTIPLY
—at the AWWA Convention

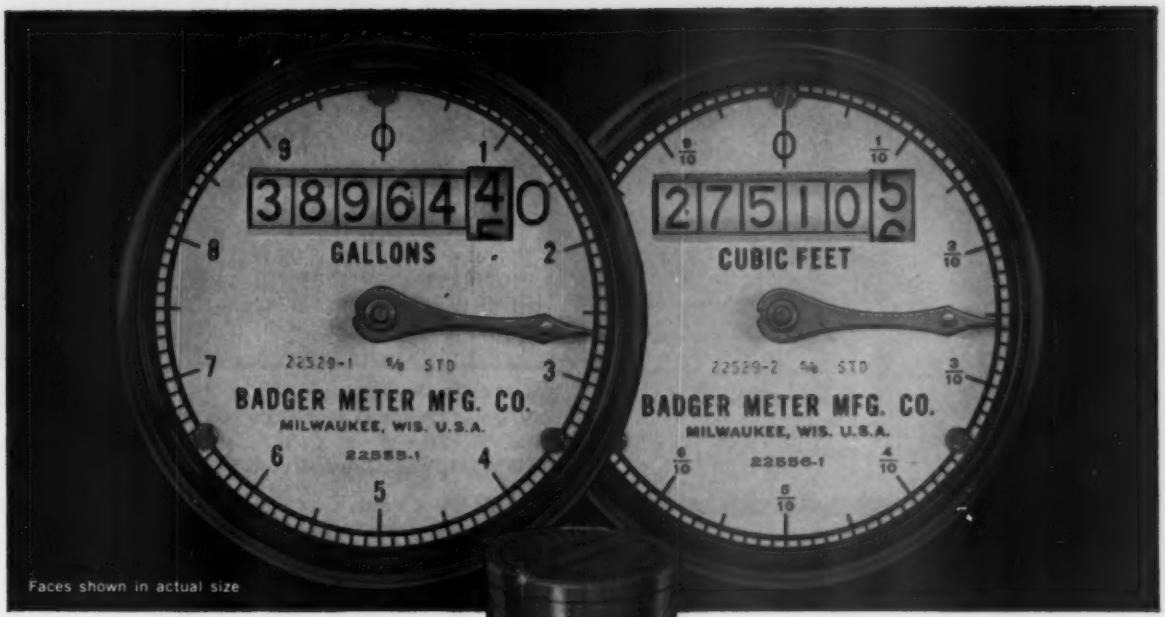


Rex Verti-Flo not only increases the clarifying capacity of tanks up to four times; it provides a far clearer effluent. The savings in equipment and construction costs are obvious. Here's how Verti-Flo does it: The unique design of Rex Verti-Flo Clarifier transforms the conventional horizontal-flow tank into a vertical-flow tank...utilizing the *full volume* of the tank and *minimizing short-circuiting*. This is accomplished by a system of collecting troughs, weirs and partitioning baffles which divide the large, horizontal settling zone into a series of small, vertical-flow cells. To assure maximum flow length and control, the weirs are adjustable entirely around the periphery of each cell.

Installed in existing tanks, Verti-Flo can be at least double the capacity of the tank...in new installations, Verti-Flo provides up to four times more capacity so that smaller basins can be used with considerable savings in both equipment and construction costs.

For information, write CHAIN Belt Company, 4610 W. Greenfield Ave., Milwaukee 1, Wis.

REX®
CHAIN BELT COMPANY



Easy-Read Model A
frostproof design
5/8" through 1" x 1¼"

Bigger face, better features make new Badger *Easy-Read* a standout

You're looking at the life-size face of the new Badger Easy-Read magnetic drive meter. Its biggest-face-in-the-industry (¼" high digits) is just one of Easy-Read's exclusives. Here's more:

SEALED, REMOVABLE REGISTER — Off comes its head without even disturbing the meter in the line. Easy-Read's register and cover can also be mounted in any of four positions for most convenient reading. Register and gear train parts operate in a clean, dry, lubricated, sealed housing to forever eliminate fogged registers.

TRULY PERMANENT MAGNETIC COUPLING — Easy-Read's ceramic magnets are made of high-quality barium alloy material — rustproof, noncorrosive, proven truly permanent. No stuffing box needed.

INTERCHANGEABLE PARTS — If yours is a Badger meter system, many parts in the new Easy-Read are interchangeable with the parts in your present meters.

Ask your Badger representative soon for a demonstration of the new Badger Easy-Read magnetic drive meter.

Split-case
Easy-Read meters
5/8" through 2"

* Trademark

Badger Meter Mfg. Company

4545 West Brown Deer Road • Milwaukee 23, Wisconsin

Don't throw maintenance money away!
NoDrip TAPE PERMANENTLY PROTECTS AGAINST CONDENSATION AND RUST AT LOWEST COST.

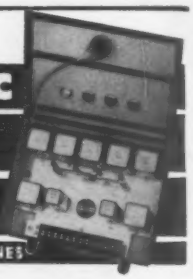
Any maintenance man can check this. Handy 16' rolls of ¼" thick NODRIP TAPE fits any size pipe or fitting. Never absorbs moisture. *Permanently* insulates against damaging pipe sweating—even around unions, tees, angles and valves.

NoDrip PLASTIC COATING
Another fine Mortell product. Use on metals, concrete, brick, tile, plaster surfaces. Apply by brush, trowel or spray to large pipes, tanks, walls, ceilings, air ducts, to eliminate sweating. 1 or 5 gal. cans or 55 gal. drums.

At all leading hardware, mill supply and plumbing jobbers. For full information and technical handbook, write

Mortell COMPANY
599 Burch Street, Kankakee, Ill.

Synchro-Start
FULL AUTOMATIC
ENGINE
CONTROLS
FOR GASOLINE DIESEL & GAS ENGINES



Synchro-Start's new protective engine controls have been designed, for the starting and stopping of engines from remote pilot devices, such as pressure switches, float switches, power failure relays, etc., and are completely automatic in operation.

These dependable controls are encased in a steel, dust proof cabinet, and now feature enclosed PLUG-IN RELAYS as well as OVERLOAD BREAKERS. The plug-in relays simplify what little field maintenance that may have been required in older models, while the overload breakers eliminate the necessity of replacing fuses.

In designing this unit we have used the same high quality materials and workmanship that our customers have come to expect throughout Synchro-Start's 27 years of manufacturing engine controls.

SYNCHRO-START PRODUCTS, INC.
Since 1932
8151 NORTH RIDGEWAY AVENUE • SKOKIE, ILLINOIS

Meetings

WHAT WHEN WHERE

1961

APRIL							MAY							JUNE						
						1		1	2	3	4	5	6					1	2	3
2	3	4	5	6	7	8	7	8	9	10	11	12	13	4	5	6	7	8	9	10
9	10	11	12	13	14	15	14	15	16	17	18	19	20	11	12	13	14	15	16	17
16	17	18	19	20	21	22	21	22	23	24	25	26	27	18	19	20	21	22	23	24
23	24	25	26	27	28	29	28	29	30	31				25	26	27	28	29	30	
30																				

May 14-17—Austin, Texas (*The University of Texas*) WATER UTILITY MANAGEMENT INSTITUTE. Write: Dr. E. F. Gloyna, College of Engineering, Taylor Hall 211, The University of Texas, Austin 12.

May 22-24—Ocean City, Md. (*Commander Hotel*) MARYLAND-DELAWARE WATER & SEWAGE ASSN. Secy., W. M. Bingley, State Dept. of Health, 301 W. Preston St., Baltimore 1, Md.

May 22-26—Cincinnati, Ohio (*Robert A. Taft Sanitary Engineering Center*) Training course: "Inorganic Industrial Wastes Characterization." Write: Chief, Training Program, Robert A. Taft Sanitary Engineering Center, 4676 Columbia Parkway, Cincinnati 26, or to PHS Regional Office.

May 22-26—University Park, Pa. (*The Pennsylvania State University*) Advanced Water Works Operators Course. Write: Director, Continuing Education in Engineering, 231 Sackett Bldg., The Pennsylvania State University.

May 25-26—Pullman, Wash. (*Washington State University*) 10th PACIFIC NORTHWEST INDUSTRIAL WASTE CONF.

May 31-June 2—East Lansing, Michigan (*Michigan State University*) MICHIGAN SEWAGE & INDUSTRIAL WASTES ASSOC. Secy., D. M. Pierce, Mich. Dept. of Health, Room 311, Admin. Bldg., Lansing 4, Mich.

June 1-3—Windsor, Ont. (*Prince Edward Hotel*) CANADIAN SECTION A.W.W.A. Secy., A. E. Berry, 72 Greenville St., Toronto, Ont.

June 4-9—Detroit, Mich. (*Cobo Hall*) A.W.W.A. ANNUAL CONFERENCE. Secy., R. J. Faust, 2 Park Ave., New York, N. Y.

June 5-7—Tuscaloosa, Alabama (*University of Alabama*) ALABAMA WATER & SEWAGE ASSN. Secy., E. J. Finnell, Jr., Univ. of Alabama, University, Ala.

June 5-7—Pullman, Wash. (*Washington State University*) 7th SEWAGE WORKS SCHOOL.

June 6-8—Morgantown, West Virginia (*West Va. University School of Mines*) SIXTH ANNUAL APPALACHIAN UNDERGROUND CORROSION SHORT COURSE. Write: Mr. John H. Alm, Dearborn Chemical Co., 2 Gateway Center, Pittsburgh 22, Pa.

June 7-9— Springfield, Ill. (*Leland Hotel*) CENTRAL STATES SEWAGE & INDUSTRIAL WASTES ASSN. Secy., Scott E. Linsley, 2400 Childs Rd., St. Paul 6, Minn.

June 7-9—Okoboji, Iowa (*The New Inn*) IOWA SEWAGE & INDUSTRIAL WASTES ASSN. Secy., L. F. Skorczeski, 207 S. 15th Ave., Marshalltown, Iowa.

June 11-15—New York, N. Y. (*Hotel Commodore*) 54th ANNUAL MEETING AIR POLLUTION CONTROL ASSOCIATION.

June 14-16—Cleveland, Ohio (*Statler-Hilton Hotel*) 35th Annual Meeting OHIO WATER POLLUTION CONTROL CONFERENCE. Write: Mr. E. B. Ransom, Secy., 101 North High St., Columbus.

June 15—Portsmouth, N. H. (*Wentworth-by-the-Sea*) NEW ENGLAND WATER WORKS ASSOCIATION.

June 19-21—New Brunswick, N. J. (*Rutgers University*) Short Course: Analysis of Water and Sewage, Contact Dean, College of Engineering, Rutgers, The State University, New Brunswick, N. J.

June 19-23—New York, N. Y. (*Manhattan College*) Sixth Course on Bio-Oxidation of Organic Wastes Theory and Design. Write: W. W. Eckenfelder, Civil Engineering Dept., Manhattan College, New York 71, N. Y.

June 19-30—Cincinnati, Ohio (*Robert A. Taft Sanitary Engineering Center*) Training course: "Aquatic Biology for Engineers." Write: Chief, Training Program, Robert A. Taft Engineering Center, 4676 Columbia Parkway, Cincinnati 26, or to PHS Regional Office.

June 20-22—Wernerville, Pa. (*Galen Hall Hotel*) PA. SECTION A.W.W.A. Secy., L. S. Morgan, 413 National Bldg., Greensburg.

June 20-23—Brighton, England. Annual Conference—The Institute of Sewage Purification.

June 27—Wayne, N. J. (*North Jersey Country Club*) N. J. SECTION A.W.W.A. Secy., A. F. Pleibel, R. D. Wood Co., 683 Prospect St. Maplewood.

July 24-28—Cincinnati, Ohio (*Robert A. Taft Sanitary Engineering Center*). Short Course: Recent Developments in water Bacteriology. Write: Chief, Training Program, Robert A. Taft Sanitary Engineering Center, 4676 Columbia Parkway, Cincinnati 26, or to PHS Regional Office Director.

Sept. 11-13—Louisville, Kentucky (*Brown Hotel*) KENTUCKY-TENNESSEE SECTION A.W.W.A. Secy., Harold F. Mount, Preston Street Road Water Dist. No. 1, 5400 Preston Highway, Louisville, Ky.

Sept. 12-Oct. 5—New Brunswick, N. J. (*Rutgers University*) Short Course: Water Works and Filter Plant Operation. Contact Dean, College of Engineering, Rutgers, the State University, New Brunswick, N. J.

Sept. 13-15—Saranac Lake, N. Y. (*Saranac Inn*) N.Y. SECTION A.W.W.A. Secy., Kimball Blanchard, Neptune Meter Co., 2222 Jackson Ave., Long Island City 1.

Sept. 13-15—St. Paul, Minn. (*Hotel Lowry*) NORTH CENTRAL SECTION A.W.W.A. Secy., Carl A. Flack, Water Dept., 216 City Hall, St. Paul 2, Minn.

Sept. 17-21—Poland Spring, Maine. Annual Convention NEW ENGLAND WATER WORKS ASSOCIATION.

Sept. 20-22—Rapid City, South Dakota (*Sheraton-Johnson Hotel*) JOINT MEETING SO. DAK. WATER & SEWAGE WORKS CONF., SO. DAK. SECTION A.W.W.A. and SO. DAK. WATER POLLUTION CONTROL ASSN. Secy., Don C. Kalda, So. Dak. Water and Sewage Works Conf., Div. of San Engrg., State Board of Health, Pierre, So. Dak.

PURER WATER
Ferri-Floc
FERRIC SULFATE
We can help you with your water purification problems — coagulation, softening, removal of iron and manganese. We have reliable technicians ready to assist you in producing purer water. Let us send you complete information on Ferri-Floc.
SODIUM SILICOFLUORIDE
A white powder or granule (dyed blue if desired) for fluoridation of potable water.
TC TENNESSEE CORPORATION

ELECTRICALLY CONTROLLED CHLORINATION SYSTEMS

The commands are electric. The operation is automatic. Engineered by Fischer & Porter . . . chlorination goes modern.

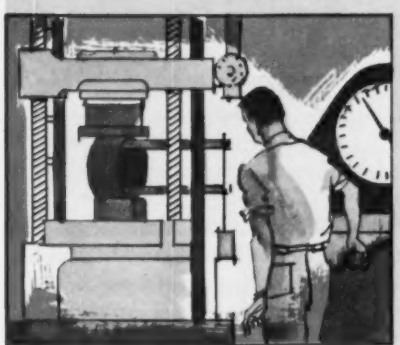
Regulate chlorine feed rate *precisely*, *automatically* with electrical signals from program controllers, multiple and step rate controllers, automatic proportioning controllers, remote controllers, magnetic flowmeters, and residual analyzers. Don't invest in *any* chlorination system until you check out Fischer & Porter Electrically Controlled Chlorination Systems. Fischer & Porter Company, 151 Fischer Road, Warminster, Pennsylvania. In Canada, write Fischer & Porter (Canada) Ltd., 2700 Jane Street, Toronto.

FP FISCHER & PORTER COMPANY *CHLORINATION AND INSTRUMENTATION*

PIPE FACTS

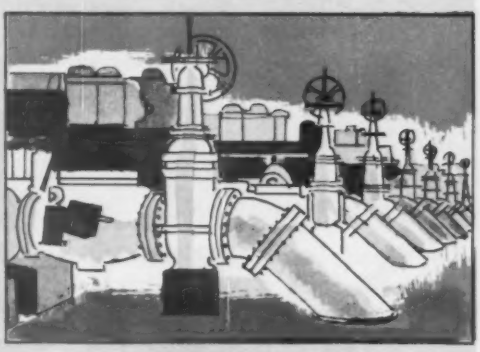
In a recent survey, ten times as many contractors claimed more difficulty (breakage during installation) with composition pipe than with cast iron pipe.

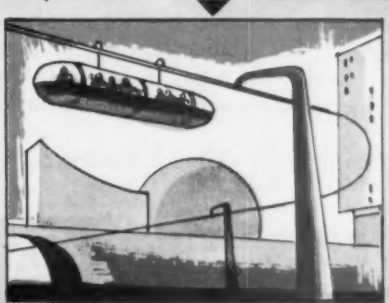
DO YOU KNOW that today's modern fire engines can pump up to 1,500 gallons of water per minute? When fire strikes, it is important that underground mains deliver the volume of water for which they were designed. AMERICAN Enamelined cast iron pipe assures high flow capacity, guaranteeing Class 150 6" pipe to have up to 13% additional carrying capacity over composition pipe of similar size and class.



DO YOU KNOW that AMERICAN cast iron pipe products are rigidly tested for quality and strength before shipment? In certified ring crushing tests—which indicate pipe's ability to take rugged punishment during installation and in service—samples of AMERICAN cast iron pipe withstood a crushing load of over 18,000 pounds! Similar samples of composition pipe failed at 6,480 pounds.

DO YOU KNOW that many thousands of miles of cast iron pipe installed this year will still be serving 100 years hence? No science fiction... this is a fact! In 100 cities in America, cast iron pipe has been in service for over 100 years...and some European cities boast a record of over 200 years use.

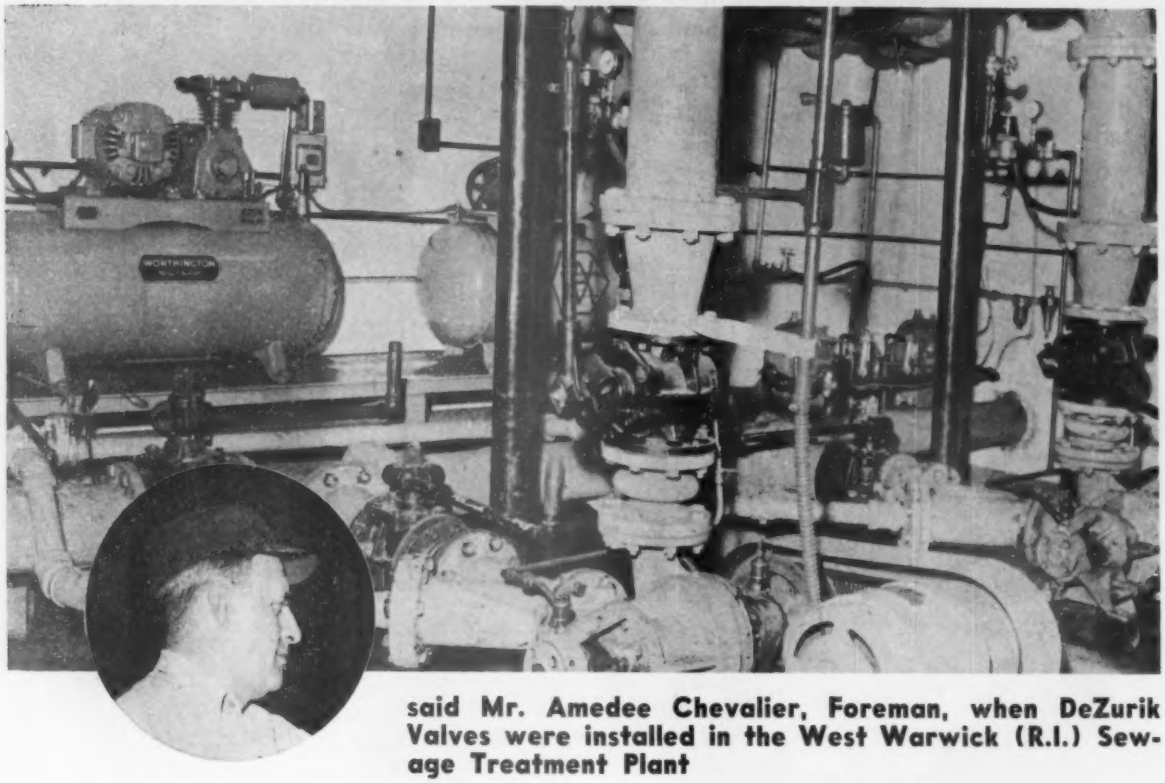




DO YOU KNOW that water to cool the launching pads at a U. S. Air Force missile test center is conveyed through large diameter AMERICAN cast iron supply lines? And that it is pumped through high pressure pumping stations equipped with AMERICAN flanged pipe and fittings? AMERICAN offers the most complete line of cast iron piping to meet water, sewage treatment and industrial plant service. Let us recommend the exact piping for your application.

AMERICAN CAST IRON PIPE COMPANY
BIRMINGHAM ALABAMA

"...that was the end of valve maintenance and dripping on the primary sludge line,"



said Mr. Amedee Chevalier, Foreman, when DeZurik Valves were installed in the West Warwick (R.I.) Sewage Treatment Plant

This kind of response . . . and from the plant foreman who works with the valves . . . is particularly pleasing to us. But it's not the whole story.

Mr. Chevalier tells us that near the end of 1955 the previous valves on the primary sludge lines of the West Warwick Plant required constant maintenance and dripped continuously. They were replaced with DeZurik Valves and, Mr. Chevalier says, "that was the end of valve maintenance and dripping."

Then, late in 1960, he had occasion to drain the line and out of curiosity he removed two of the seven DeZurik Valves that had been installed. "I found them to be in the same condition as the day they were installed!"

"The primary sludge line is about the best test for a valve of this type. The valves are opened and closed at least 18 to 20 times a day; sludge flowing through contains sand, grit and other abrasives. If it stands up under these conditions, it has to be good. We plan to replace other valves in our system in the near future and the replacements will be DeZurik Valves."

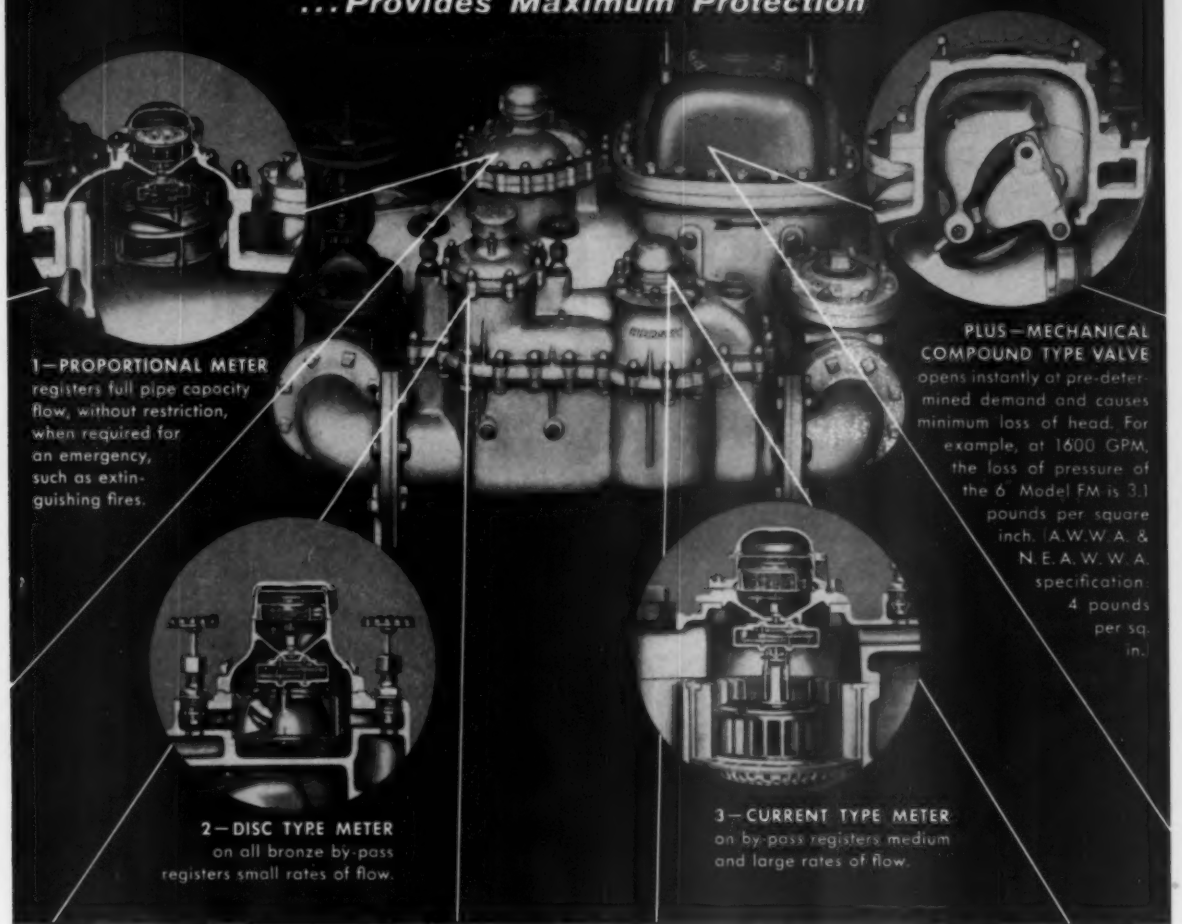
Why not try DeZurik Valves on *your* difficult services?

Get the complete details on DeZurik Valves from the DeZurik representative in your area, or write for Bulletin 110.

DeZURIK CORPORATION
SARTELL, MINNESOTA

3-in-1 FIRE SERVICE METER PRODUCES MAXIMUM REVENUE

...Provides Maximum Protection



1—PROPORTIONAL METER registers full pipe capacity flow, without restriction, when required for an emergency, such as extinguishing fires.

2—DISC TYPE METER on all bronze by-pass registers small rates of flow.

3—CURRENT TYPE METER on by-pass registers medium and large rates of flow.

PLUS—MECHANICAL COMPOUND TYPE VALVE opens instantly at pre-determined demand and causes minimum loss of head. For example, at 1600 GPM, the loss of pressure of the 6" Model FM is 3.1 pounds per square inch. (A.W.W.A. & N.E.A.W.W.A. specification: 4 pounds per sq. in.)

HERSEY

Detector (FIRE SERVICE) Meter – Model FM-CT

Sizes 6", 8" and 10" of Model FM-CT with Compound by-pass and sizes 3" through 10" with Disc by-pass are listed as standard under the Re-examination Service of Underwriters' Laboratories, Inc., and approved by Factory Mutual Laboratories for use in Factory Mutual insured properties, also listed by Underwriters' Laboratories of Canada.

VISIT OUR EXHIBIT AT THE AWWA CONFERENCE JUNE 4-9, COBO HALL, DETROIT, MICH. YOU'LL FIND US IN BOOTH Nos. 106, 108, 110, 112.

Hersey-Sparling
Meter Company
HERSEY PRODUCTS
DEDHAM, MASSACHUSETTS

Branches: Atlanta, Boston, Chicago, Cleveland, Dallas, Denver, Kansas City, Mo., Los Angeles, New York, Philadelphia, Portland, Ore., San Francisco, Seattle.

The quality of leadership!

The leaders of hundreds of America's major industries have, for twenty years, matched beliefs with action by supporting the Payroll Savings Plan for U.S. Savings Bonds. On this, the 20th Anniversary of this great idea, we salute the quality of leadership which continues to use this plan to create reserve public buying power, improve employee morale and strengthen the economy of our country. To learn how your company can benefit from the Payroll Savings Plan, write: **U.S. SAVINGS BONDS DIVISION, TREASURY DEPARTMENT, Washington 25, D.C.**

20th ANNIVERSARY 1941 1961

WATER & SEWAGE WORKS

The U.S. Government does not pay for this advertisement. The Treasury Department thanks, for their patriotism, The Advertising Council and the donor above.

Springfield's 36-Inch Chapman Sluice Gate Still Operates Easily

The stamina built into this Chapman sluice gate over half a century ago is strikingly demonstrated by easy operation when called upon, despite years of inactivity. The reserve of ruggedness engineered into a Chapman product is evident here, and while the usual service will rarely make demands to this extreme, the inherent safety margin is an important asset to any installation ▪ The progressively managed Springfield Massachusetts Water System, widely known for the purity of its water, has many other Chapman valves in service. In the opinion of Peter C. Karalekas, Chief Waterworks Engineer, Chapman valves are superior to the requirements of standard AWWA Specifications. "When I bury a valve underground where it will be for years," stated Mr. Karalekas, "I want assurance that it will not deteriorate, that it will perform its function whenever the need arises. That is why we buy Chapman's complete line." ▪ Chapman has for over 80 years designed, engineered, and manufactured one of the most complete lines of waterworks valves in the industry.

TOTALLY SUBMERGED (AND UNTOUCHED) FOR OVER 50 YEARS

Typical of the other Chapman waterworks valves now in service at Springfield are:

36-inch pivot valve with 6-inch air-vacuum relief valve and 18-inch cone throttling valve on 42-inch bypass from reservoir to settling basin.

Double-disc gate valves, from 2 to 24 inches, on transmission and distribution lines throughout system and in hydroelectric plant.

72-inch Dow disc-arm pivot valve throttles flow from main reservoir to basin at filter beds.

42-inch gates on 60-inch transmission lines and in distribution reservoirs.

24-inch hydraulically operated gate valves on aerator.

Write to us about your valve application problems. Our engineers will provide expert advice promptly without obligation.

THE CHAPMAN VALVE

MANUFACTURING COMPANY ■ INDIAN ORCHARD, MASSACHUSETTS ■ A SUBSIDIARY OF CRANE CO.

ARE YOU GIVING AWAY TONS OF WATER

...just to save a few cents?

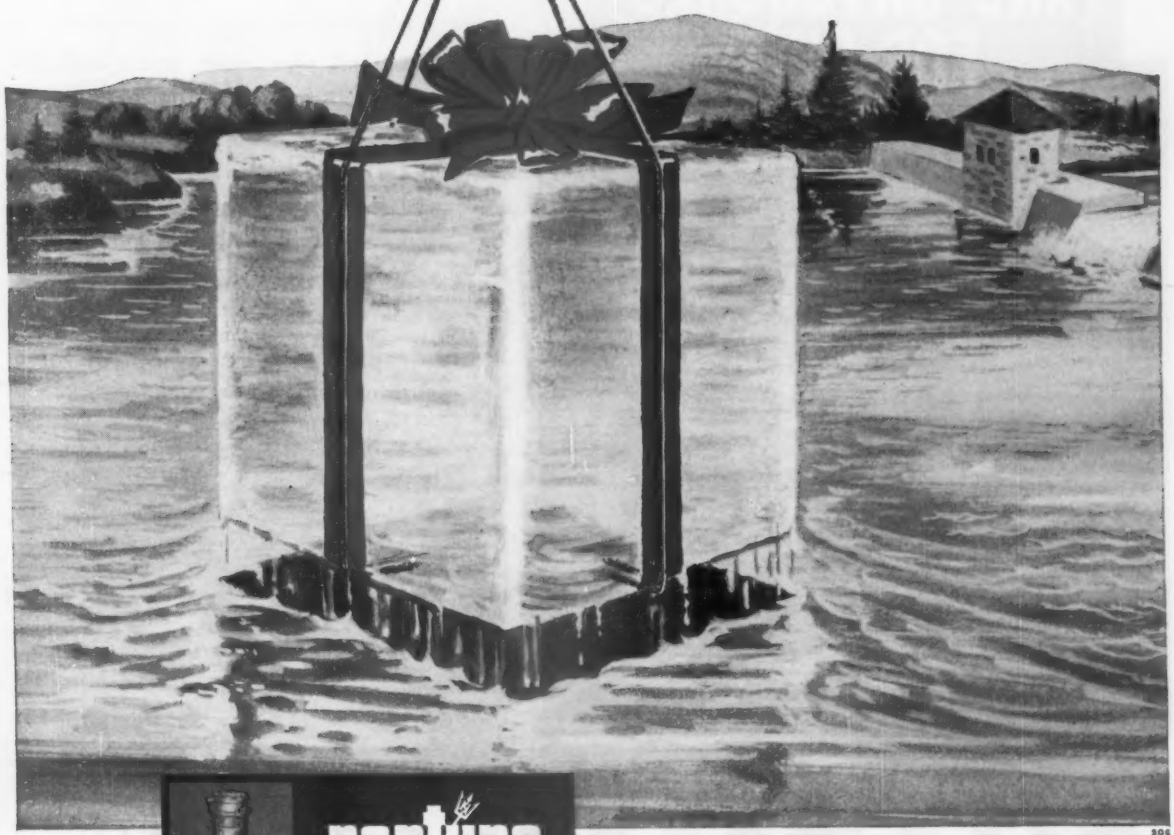
The value of a water meter is not what it costs, but what it *earns*. Actually, its "bid price" is only your down payment, and could well be the only *easy* payment.

There are two reasons. First, like any fine instrument, a water meter loses accuracy as it wears. After a few years... or a few months... it begins to lose revenue. If you buy on price alone, you may soon find the meter giving away far more than the few cents you thought you saved.

Secondly, to keep the meter accurate, you may have high repair costs... or premature scrap-and-replace programs. Different makes of meters vary widely in this respect.

Water is your city's most vital service. You entrust it to the accuracy of your meters. To be sure of this accuracy, visit your meter shop. Ask which meter gives highest sustained revenue... with lowest repair and depreciation costs.

We sincerely believe the answer will be "Trident." 15,000,000 since 1898... the world's leader.



neptune
TRIDENT WATER METERS

NEPTUNE METER COMPANY
LIQUID METER DIVISION

47-25 34th St. Long Island City 1, N. Y. / Neptune Meters, Ltd., 1430 Lakeshore Rd., Toronto 14, Ont. / Offices in Principal Cities

Vol. 108, No. 5 • May 1961
WATER & SEWAGE WORKS
A Scranton Gillette Publication

Bascule Gates for increasing reservoir capacity

by G. E. THOMAS,
Project Engineer
Metcalf & Eddy, Engineers
Boston, Mass.

RESUME: The capacity of a reservoir can be increased in many ways. Of these, the more popular methods are raising the spillway crest, flashboards, by excavating in the reservoir, and by installing radial or bascule gates. With the exception of the two types of gates, the other methods are quite costly either for first cost or maintenance.

Bascule gates are usually the most desirable of the types of gates since they do not require an overhead structure. Further, they provide automatic opening and closing controlled by the water level in the reservoir. Various installations of this type gate, which is basically a hinged steel flash board, have shown it to be quite useful.

■ WITH THE OVERWHELMING increase in water consumption over the past twenty years, together with the frequent dry periods encountered, increasing water storage capacities has become a subject of universal consideration. For this reason increasing critical attention is being given to considerations of water reservoirs and, in particular, to the problem of how an existing reservoir can be modified to increase its storage capacity.

In general, increasing the storage capabilities of existing reservoirs can be approached in a number of ways. One method, gaining considerable interest of late, is the use of bascule gates. In order to appreciate the advantages of this unit, it will be necessary to briefly review the other methods in current use.

Raising Spillway Crest

A permanent increase can be obtained by raising the elevation of the spillway crest. Depending upon the adequacy of the original flow capacity of the spillway, it is generally necessary to increase the height of the spillway abutments and embankment sections of an earth dam and the non-overflow sections of a concrete dam in order to maintain the required spillway capacity and freeboard. The costs associated with this method of modification are usually considerable, because of the sizeable quantities of concrete required to gain additional height and to preserve the symmetry of the spillway, in addition to the costs of hauling and placing additional earth on the embankment under restricted space conditions.

Flashboards

A common method of providing a temporary increase in reservoir storage capacity is the use of flashboards. These are generally installed after the flood season and remain in place until removal just before the start of the next seasonal flood period.

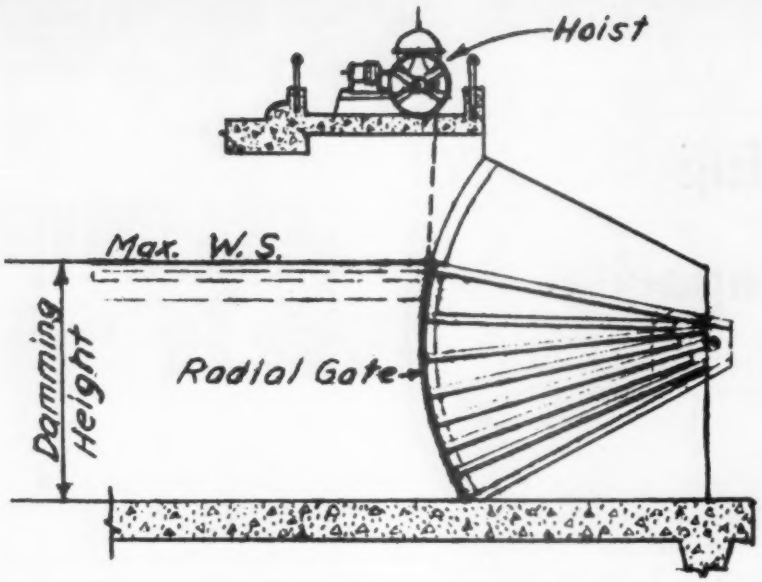
Flashboards are usually attached by wire to vertical metal pipes or pins secured to the crest of the spillway. These pipe or pin supports are designed to fail under a predetermined head of water flowing over the top of the boards. With the collapse of the boards under such conditions the design capacity of the spillway is restored, thus preventing the dam from being overtopped.

The failure of flashboards is naturally quite sudden, and the resulting surge or wave of water which develops downstream can be damaging to structures in its path. At the same time, the gain in water storage from the installation is totally lost. The installation must be replaced before storage can once again start building up.

Flashboards involve a relatively low initial cost. The maintenance work required, however, can be appreciable. For one thing, there can be considerable difficulty in minimizing leakage. Untimely failure of flashboards can also occur due to an unexpected flash flood. When failure does occur, whether expected or otherwise, most of the boards will be swept downstream while others will be damaged considerably. At the same time, many of the supports will be bent or otherwise damaged and will also require replacement.

When replacing a flashboard installation that has failed, there is the chance that the new or repaired supports will be inconsistent with the design strength of the initial installation. Such a condition can result in the flashboards failing prematurely or not failing at all. In the latter case, the required waterway will not be available and the dam may be overtopped with considerable damage or possible failure.

Two other types of board installations are the hinged type and the fixed stop-log type. The first consists of panels hinged at the crest of the spillway. The panels are supported on the downstream side by wooden



A TYPICAL RADIAL gate installation.

struts designed to fail at a predetermined head of water. Although the boards are not lost with this type of installation, the other disadvantages still prevail. A stop-log installation consists of boards secured in fixed vertical guides. Since the boards must be removed manually, it is essential that they be kept free working and that operating personnel be extremely vigilant of water level.

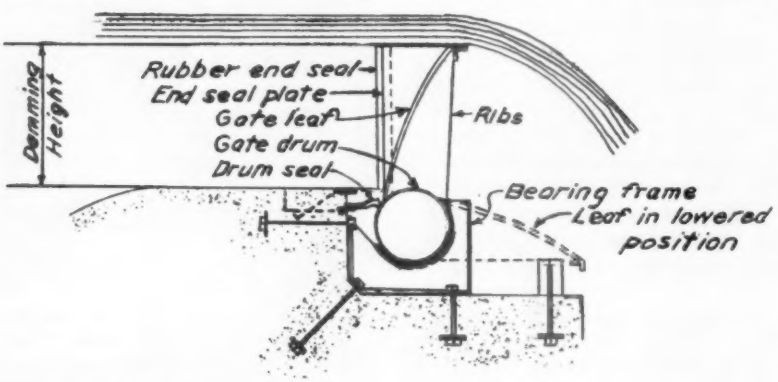
Because of the number of variables involved, some state regulatory agencies will not permit flashboard installations except under carefully supervised conditions.

Excavation in Reservoir

In some instances reservoir storage capacity can be increased by excavation in the reservoir area. With this method, however, there exists the possible danger of increasing seepage around the rim of the reservoir or under the dam itself, assuming there is no complete cutoff under the structure. The cost of this operation can be very high.

Radial Gates

Another method of increasing reservoir storage is with the use of crest gates. One type of crest gate is the radial or Taintor gate, which rotates about a trunion on the crest of the spillway. The gate is operated by an overhead hoisting device connected by cable or chain to its two lower corners. The thrust from the water pressure is carried by the trunion bearing which offers little resistance to the operation of the gate. The operating load consists of the dead weight of the gate, ice load, friction, and the torsional resistance of the trunion bearings. The primary feature of these gates is their simplicity of operation. It is generally necessary to construct an overhead operating structure the entire length of the spillway. In some instances the position of an existing bridge over the spillway prevents use of this type of gate installation.



ELEVATION VIEW of a bascule gate installation.

Bascule Gates

The bascule gate is a particular type of crest gate which possesses the advantageous features of the radial type crest gate plus the feature of gradual automatic raising and lowering. Although capable of manual operation when desired, bascule gates normally function automatically. The automatic opening and closing of the gates is controlled by predetermined maximum and minimum reservoir levels. It is this automatic operation without the loss of water storage which makes the bascule gate so desirable.

Basically, the bascule gate is a hinged flashboard. Constructed of steel, it consists of a contoured gate leaf attached to a torsion cylinder which rotates on a series of bearings secured to the crest of the dam. The ends of the torsion cylinder are set in the spillway abutments. A lever assembly, attached to one end or both ends of the torsion cylinder, and the operating mechanisms are housed within the spillway abutments. Rubber sealing strips mounted on the piers and on the crest of the spillway complete the closure of the gate leaf when it is in the vertical position, preventing water seepage around or under the gate. A series of bearing frames, mounted on the spillway, support the torsion cylinder.

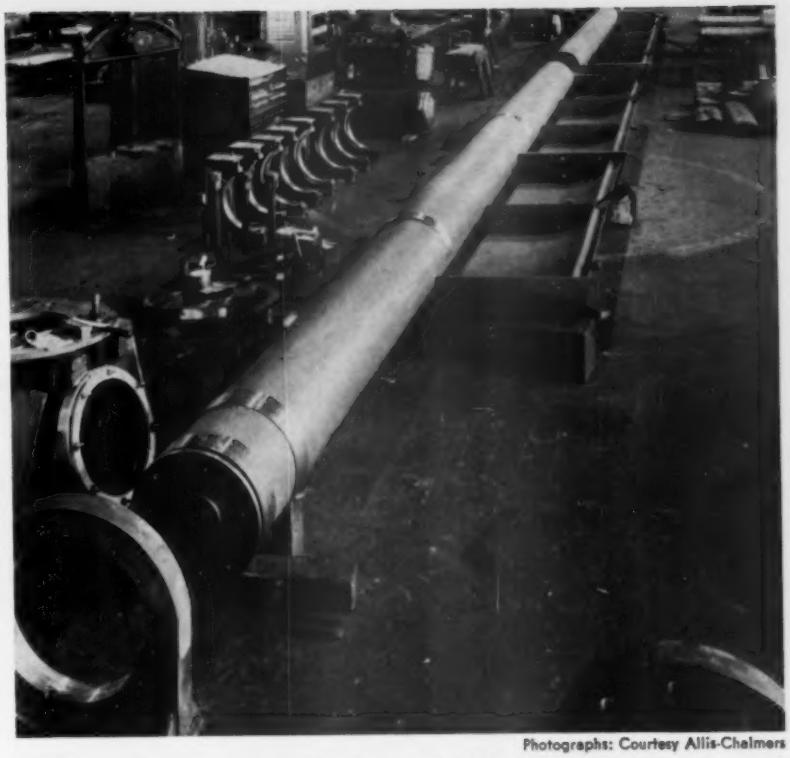
To mount the bascule gate, a section of the dam crest is cut away and the bearing assemblies are secured to the dam at equal intervals. For operation in the winter months, electric heaters are installed at the seals, and heating of the torsion cylinder is also provided to prevent the formation of ice from interfering with the operation of the gate.

The bascule gates are operated hydraulically with an oil pressure of 300 to 400 psi. The automatic control feature is accomplished by means of a float valve and well which duplicates the level of the reservoir. A relief valve is provided in the oil line to allow for excessive pressure being exerted on the gate by ice or debris

when the gate is in a vertical position. When such pressure are exerted on the gate, it will lower automatically to permit the debris or ice to pass over the crest. This relief valve also acts as a safety device in that it can be operated to lower the gate under flood conditions should operating valves become inoperable or the oil lines become plugged.

Normal raising or lowering of the gates is governed by a throttling valve, the rate of speed being about 1 ft per minute. A compensating mechanism is provided to prevent overtravel.

Bascule gates are available in single span sizes up to 10 ft in height and 100 ft in length. They are constructed in sections to facilitate handling, field erection, and assembly. For spillway spans in excess of 100 ft, the gates are installed in sections. For a bascule gate installation having two separate spans, separate operating mechanisms are provided at either end of the dam. With a multispan installation, there is the advantage of having one gate set for automatic regulation of minor variations in reservoir level, and the others set for automatic operation to handle the larger variations in reservoir level.



Photographs: Courtesy Allis-Chalmers

SHOP VIEW of gate assembly showing fabricated torque tube, gate leaf, and mounting bearings.

Installations

A typical installation of bascule gates was recently designed and supervised by the author's firm, for the North Fork Reservoir Dam of the Johnstown Water Company in Pennsylvania. The gates were manufactured by Allis-Chalmers Manufacturing Company of York, Pennsylvania. The dam had an ogee type spillway which was divided into three bays by two concrete bridge piers which supported an overhead concrete service bridge.

The Johnstown Water Company was faced with the urgent problem of increasing the storage capacity of the reservoir. Raising the crest of the concrete spillway and embankment of this earth dam was not feasible. State regulation prohibited a flashboard installation, and radial crest gates could not be employed because of the overhead bridge. The State also required that the original spillway capacity should not be reduced. Bascule gates were ideally suited to this set of conditions.

To permit installation of the bascule gate, a section of the concrete spillway was removed. Because of the relatively short span between bridge piers, one continuous torsion cylinder was used. Holes were drilled through the two division piers and one dam abutment. Holes and slots were made in the concrete spillway for the placement of anchor straps and bolts. A concrete apron was placed over the horizontal surface of the recessed section of the spillway. The seal plate, sill beam, and anchor straps were then grouted into place in the vertical surface of the recessed spillway section. Three bronze-lined saddle bearings were installed on the concrete apron in each bay to support the torsion cylinder.

The end seals of the gates at the piers and abutments consist of steel plates set out from the supports a distance of 6 in., with nonshrink grout used to fill the void between the steel plate and the supports. The actual water seal is accomplished by a length of rubber tubing attached to the steel plate.

An underground control room was constructed in the enbankment adjacent to the left abutment, this side of the dam being closest to the access road and power lines. The room is 10 ft wide, 14 ft long, and 12 ft high, with concrete floor, walls, and roof. Housed within the control room are the oil pumping unit, the hydraulic cylinder and operating lever, control panel, and float well. The float well consists of a 24 in. diameter, Schedule 40 standpipe, with a 2 in. intake pipe leading from the reservoir just upstream of the spillway crest, and passing through the abutment wall to the float well. Electrical service is provided for operation of the oil pressure pump, lighting, and heating. A floor drain was included, discharging downstream into the spillway channel. The drain serves a dual purpose: it supplies air to the control room to replace that exhausted by the roof ventilator; and, with the onset of winter, the drain is used for the purpose of emptying the water from the float well. Use of the gates for the purpose of increasing storage was limited by State regulation to the period of April 15th through November 15th. For this reason, no heating provisions were included.

As a result of this 3 ft high Bascule gate installation, the 1100 million gallon reservoir storage capacity was increased by about 92 million gallons.

At York, Pa., bascule gates were found to be ideally suited to the spe-

A SET OF GATES in the process of installation.

cific needs of the York Water Company. Two improvements were desired: to increase the capacity of the existing spillway, and to increase the capacity of storage in the reservoir. The existence of a state highway bridge over the spillway was an extremely critical factor. It was not possible to raise the bridge a sufficient amount so that both an increased spillway capacity could be obtained and the crest of the spillway be raised for the purpose of increased storage. The solution was obtained by raising the bridge a sufficient amount above the existing spillway crest for the needed increase in spillway capacity; this with an installation of bascule gates which would provide the desired increase in storage capacity and at the same time not affect the required spillway capacity during the flood season of the year. These gates were 4 ft high and built in two 93 ft sections, individually controlled by separate operating mechanisms in either abutment. As a result of the gates, a 900 million gallon storage was increased at the York Water Company Reservoir by about 250 million gallons.

A BASCULE GATE in the lowered position.

The application of bascule gates on reclamation dams, water supply projects, and power dams is becoming quite popular. In addition to the Pennsylvania installations, they can be found at Athol, Mass.; at a dam performing flood control service in Orange, Mass.; near Boston, Mass. controlling the stream flows of the Neponset and Charles Rivers; and in use under severe winter conditions at a power dam in St. Albans, Vt. Each of these installations is an example that bascule gates are the answer to the perplexing problem of increasing reservoir storage under severely limiting conditions.

Considerations

In the design of a bascule gate installation, there are some basic considerations necessary. For one thing, there is the resulting stability of the dam and the degree to which it may or may not be affected by the increased head of water made possible by the gates. In some instances, this may be the deciding factor in determining the height of the gates to be installed and, in cases where the original spillway capacity must be maintained, it is essential to investigate the resulting coefficient of discharge of a proposed gate installation. The contour of the gate will be governed accordingly.

Portland, Ore. Studies Controversial Water Proposal

The office of Portland, Ore., Commissioner, Mark A. Grayson, has initiated a study of a controversial proposal that the Portland Water Bureau increase its rates to outside users by $500,000 a year. A recent analysis by the Public Administration Service for the city concluded that many water districts served by the Bureau do not pay a fair share of costs. Needless to say, many protests followed.

Grayson declared that he had received reports and suggestions from most of the 58 outside communities that received the service's study. Meetings with water districts have been held since early February. The suggestions were reviewed by Grayson, Thomas Jacobi, a Chicago municipal consultant, and Ernest C. Willard, Portland consulting engineer, prior to the conference.

The Tri-County Water Association, which represents many of the individual water districts served by the city, charged at a late January meeting that the city was using water rates as a means to promote annexation. This group called for the establishment by the Oregon legislature of a metropolitan water district. Under this proposal, facilities at Bull Run would be taken out of the city's control.

RESEARCH PROGRESS REPORT

This first of a two part article reports on recent advances in . . .

Evaporation Suppression Research

Part I

by JOSEPH B. FRANZINI
Associate Professor of Civil Engr.
Stanford University
Stanford, Calif.

EDITOR'S NOTE: One of the most interesting aspects of evaporation suppression research is that this is one of the few areas in which work is being done which, in a manner of speaking, can add to our supply of available water. It cannot, of course, add to the amount of rainfall, but it can increase the amount of rainfall available for our use.

In this article, Dr. Franzini reviews the work that has been done in the field and the accomplishments in this area to date.

■ THE WORLD'S INCREASING population and the always improving standard of living have resulted in a rapidly growing demand for water. In the United States in 1950 over 173 billion gallons of water were used each day. By 1955 that figure had jumped to 210 billion gallons per day, an increase of over twenty per cent in five years. It is very likely that by 1985 the daily demand for water in the United States will exceed 500 billion gallons, approximately double what it is today.

In this country, nearly 20 per cent of today's water comes from groundwater and 80 per cent from surface supplies; while less than 0.7 per cent is provided by reclaimed waste water. Fifty years from now a significant portion of our water will probably come from converted salt water; and reclamation of waste water may also become an important water source. Efforts to conserve water, to use it wisely, and to re-use it in industrial processes are becoming more apparent with each passing day. In this connection attempts have been made to develop means of reducing evaporation from reservoirs. Research to date indicates that the saving of valuable water by evaporation suppression may be economically possible under certain conditions.

The amount of water lost to the atmosphere by evaporation from reservoirs is sizeable. It has been estimated that the evaporation loss from water surfaces in the 11 Western States exclusive of Alaska and Hawaii averages about 11.5 million acre-feet a year, enough to supply the domestic needs of a city the size of San Francisco for more than 90 years. At Lake Mead behind Hoover Dam, the annual evaporation of over 800,000 acre-feet is enough water to keep the spigots in the City of Los Angeles running for almost two years. Evaporation loss from small storages, particularly stock ponds is often severe, sometimes exceeding the amount of water used.

Mechanics of Evaporation Suppression

Evaporation losses can be reduced by storing water in underground basins or in surface reservoirs that are relatively deep, by controlling water consuming plants that grow in and along the banks of surface reservoirs, by covering reservoirs, and by chemical means. There are drawbacks to all of these methods. Recharging underground basins presents many problems, most surface reservoirs are apt to be relatively shallow because of the natural topography of the area, and the control of water consuming plants is generally a costly operation requiring continuous attention. Moreover, covering a reservoir by structural means is very expensive and totally unfeasible for large reservoirs. The reduction of evaporation by chemicals presents many problems some of which will be discussed in the ensuing paragraphs.

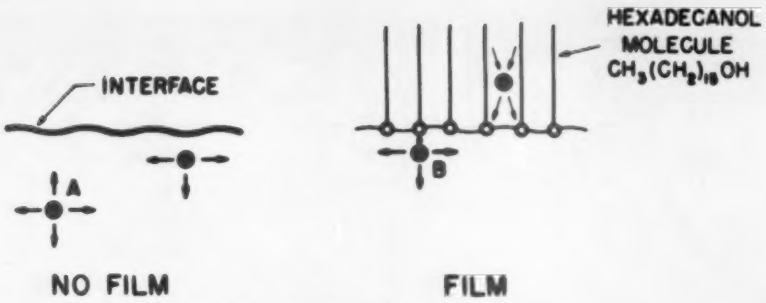


Fig. 1. THE MECHANICS of evaporation suppression.

Several years before the turn of the last century it was discovered that certain chemical compounds form a film one molecule thick on water surfaces. In the 1920's research by Langmuir, Schaefer, and others revealed that these monomolecular films could reduce evaporation. Some films were apparently much more effective than others. Recent investigations have shown that hexadecanol, CH_3 $(CH_2)_{15}OH$, also known as cetyl alcohol, and octadecanol, CH_3-$(CH_2)_{17}OH$, form films that are quite effective as inhibitors of evaporation.

Some types of molecules (hydrophylic) have an affinity for water and other types (hydrophobic) repel water. The film-forming molecules generally have a molecular structure that is composed of a hydrophylic end and a hydrophobic end. When placed on water, the hydrophylic end is attracted to the water and the other end is repelled; this causes the molecule to orient itself vertically. Hexadecanol, for example, has an hydroxyl group at the end of a long straight hydrocarbon chain hence the pencil-shaped hexadecanol molecule orients itself vertically on the water surface. The mechanics of evaporation suppression is illustrated schematically in Fig 1.

Molecule A in the interior of a liquid has, on the average, no resultant force acting on it because of attractive forces from similar molecules on all sides. Molecule A, however, is in motion and possesses kinetic energy. If molecule A were to approach the surface of the liquid, a resultant force would be exerted downward on it from the molecules below. This force causes a downward acceleration which may or may not be great enough to prevent the molecule from escaping into the vapor above the interface. Molecular activity and hence the rate at which water molecules escape from the water surface increases with temperature. In the evaporation process not only are molecules leaving the water but others are entering it from the vapor above. The rate at which molecules leave depends on the vapor pressure of the water while the rate at which they enter depends on the vapor pressure of the air above the water. Hence the rate of evaporation depends on the difference between the vapor pressure of the water and the vapor pressure of the air.

With the presence of a film it is seen that the unbalanced downward force on the water molecule B is not as great when it approaches the water surface as it had been when there was no film present. To escape out into the atmosphere, however, the water molecule B must pass between the film molecules. This requires energy and hence there is a hindrance to the passage of the water molecule through the interface. Thus evaporation is suppressed.

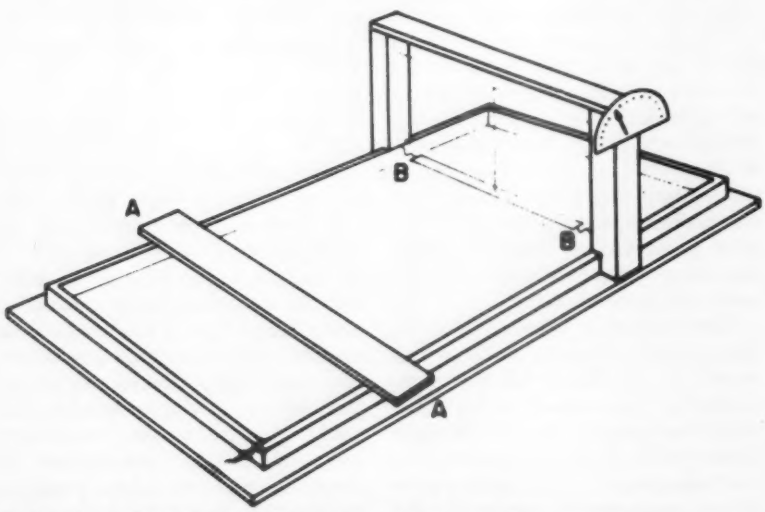


Fig. 2. A LANGMUIR TRAY for determination of film pressure.

Characteristics of the Film

A monomolecular film impedes the passage of oxygen and other gases. However, tests show that the oxygen content in reservoirs treated with film-forming chemicals has not been depressed significantly, probably because there is generally an adequate filmless area through which oxygen can pass unimpeded. This is fortunate as a reduction in the oxygen content of the water would disrupt the balance of nature and might have a deleterious effect on fish life.

When a quantity of film-forming chemical is dispensed on a water surface a film is formed immediately. This film has a thickness of less than one ten-millionth of an inch. The film generally has good spreading characteristics. Only 0.02 lb of chemical is theoretically required to form an acre of film. Tests at Stanford University showed that on a windless day a 0.10 lb dosage of powdered hexadecanol applied at a point created a film covering a 40 foot diameter circular area in less than five minutes. Within twenty minutes after application of the chemical the diameter of film coverage had increased to over 70 feet.

At a temperature of 70°F the surface tension of water is 72 dynes per centimeter. With a fully developed monomolecular film the surface tension drops to about 30 dynes per centimeter. The difference in the surface tension of water with film and without film is known as the film pressure. For a fully developed hexade-

canol film the film pressure is about 42 dynes per centimeter. Film pressures are ordinarily determined by use of a Langmuir tray, Fig 2.

Operation of this equipment is begun by filling the tray with water. Its upper edges are coated with paraffin. A measured quantity of chemical is then applied to the water surface between the barrier A-A and the boom B-B to form a film in that region. The boom B-B is attached to a torsion wire. Waxed threads extending from the ends of the boom to the walls of the tray prevent film leakage. As the barrier A-A is moved by hand toward B-B the film is compressed. Data somewhat analagous to a stress-strain test of a structural material are obtained. As barrier A-A is pushed toward B-B the position of B-B is maintained by releasing the torsion on the spring. The angle of release is measured on a circular arc. The movement of A-A is noted with the corresponding angles of release of the torsional spring. As A-A approaches B-B the film pressure increases until finally the film collapses.

Studies by electron microscope indicate that the mechanics of collapse is probably as shown in Fig 3. In the first stage of weakening some vertically oriented molecules are pushed up from the water surface until the film breaks. A double-layered ridge then rises, folds, and breaks. In the final stage the collapsed portion two molecules thick rests on the monolayer.

A plot of data from Langmuir tray tests made at Stanford University on hexadecanol films, Fig 4, show collapse occurring at a film pressure of 40 dynes per centimeter. The film pressure is determined from the angle of twist of the torsion wire while the area per molecule can be computed from a knowledge of the dosage, the molecular weight of the applied material, and the area in the tray between the boom and the moveable barrier. Fig 1 gives an indication of the flexibility of the film; i.e., as the film pressure varied from 10 to 40 dynes per centimeter the area per molecule changed from 20.2 to 18 square angstroms. The ideal film for suppressing evaporation is one whose film pressure is high; i.e., the higher the film pressure the greater the hindrance to evaporation. Hexadecanol, though an excellent evaporation retardent when fully compressed, is relatively inelastic and does not recover well once it has been compressed, decompressed, and recompressed. In other words, its healing properties are not superior. Only by supplying an excess of chemical can one be assured that a satisfactory film will be reformed after waves from wind, boats, and other disturbances have compressed portions of the film to collapse.

Another characteristic of most chemicals that form monolayers suitable for evaporation reduction is that they are consumed by certain types of bacteria such as *Psuedomonas* and *Alcaligenes*. Rates of assimilation varying from 0.03 to 0.40 lbs/day/acre have been measured in the laboratory. Another deleterious effect is that bacterial growths on the surface of discrete particles of the chemical will reduce the exposed surface and hence limit the rate of film formation.

Fig. 3. THE MECHANICS of film collapse (after Ries and Kimball).

A summary of the most important characteristics of film-forming chemicals used for evaporation suppression is as follows:

1. The material must be insoluble, non-toxic, and tasteless.
2. The film must effectively retard evaporation.
3. The chemical should be easy to administer.
4. The chemical should not be consumed too rapidly by bacteria.
5. The chemical must be inexpensive.
6. The film should have good healing properties.

Review of Past Work

It is not the intent here to review comprehensively all research in the field of evaporation suppression though some of the high points will be mentioned. In the 1920's the Langmuirs, Schaefer, Rideal, Hedestrand and others did pioneering work on monomolecular films and observed that they impeded evaporation. In recent years important fundamental research on monomolecular films has been done by LaMer, Rosano, Blank, etc. LaMer, for example, found in recent laboratory investigations that a mixture of octadecanol and hexadecanol holds the greatest promise of success for practical application.

The first field studies were those of Mansfield in Australia in the early 1950's under the auspices of the Commonwealth Scientific and Industrial Research Organization. The Australians have been working continuously on the development of practical techniques for applying film-forming chemicals to open water surfaces and have made many important contributions. In 1954 Dr. Ian W. Wark of Australia spoke on evaporation suppression at a meeting of the American Chemical Society in San Antonio, Texas. Immediate interest was aroused and a group of public spirited citizens formed the Southwest Cooperative Committee on Evaporation Control. This group later incorporated as the Southwest Water Evaporation Research Council. Funds were raised from industry, municipal water districts, and private individuals to finance research at the Southwest Research Institute. This group screened 150 film-forming chemicals to ascertain which might be most suitable for evaporation suppression. Nitrogenous compounds were ruled out because of toxicity considerations; while fatty acids were found to be undesirable because of their interaction with calcium and magnesium ions. Alkanols were found to be generally the most suitable type of film forming chemical though some have undesirable toxicity characteristics and others possess a molecular structure preventing the formation of a well compressed film. The straight chain primary alcohols, hexadecanol and octadecanol, were found to be the most suitable. The Southwest Research Institute con-

ducted the first field tests in this country. The U. S. Geological Survey assisted in these tests by evaluating the reduction of evaporation from open reservoirs.

Shortly after the Southwest Research Institute commenced its work on evaporation suppression the U.S. Bureau of Reclamation entered the picture. This agency conducted numerous pan tests to screen over 100 chemicals and applied the film to several small reservoirs near Denver, Colorado. In the summer of 1958 the U.S. Bureau of Reclamation in cooperation with the U.S. Geological Survey, the U.S. Weather Bureau, the U.S. Public Health Service, the Oklahoma State Department of Health, and the City of Oklahoma City conducted an extensive research program at Lake Hefner, a water supply reservoir for Oklahoma City. This work was perhaps the most comprehensive and carefully documented testing program on evaporation suppression that has been conducted to date. Lake Hefner, which is a 2500 acre lake, had been used in previous years as the site for some fundamental research on evaporation and, hence, was a logical choice for further studies. Hexadecanol was dispensed from a boat and barge as a powder suspended mechanically in water and sprayed under pressure by pump onto the lake surface. It was found that the film was very sensitive to wind; a gentle breeze would quickly blow away the film piling it up on the far shore. During the summer of 1958 over 40,000 lbs of hexadecanol were applied to the lake. Using a method developed by G. Earl Harbeck, Jr. of the U.S. Geological Survey the reduction of evaporation was evaluated to be 9 per cent. In this method which depends on an energy budget approach combined with mass-transfer theory the evaporation that would have occurred had no film been present is computed and compared with the evaporation that occurred with the film. A careful accounting of all expenditures showed that the cost of the "saved" water at Lake Hefner during the summer of 1958 was $61 per acre-foot, approximately equivalent to the estimated value of the Lake Hefner water. Some other results of the 1958 testing program at Lake Hefner were as follows:

1. There were no apparent toxic effects resulting from the application of the hexadecanol.
2. There were no undesirable effects on the treatment processes of the lake water.
3. There was no interference with normal recreational uses of the lake.
4. There was a large increase in the bacterial content of the water though it was deemed to be insignificant.

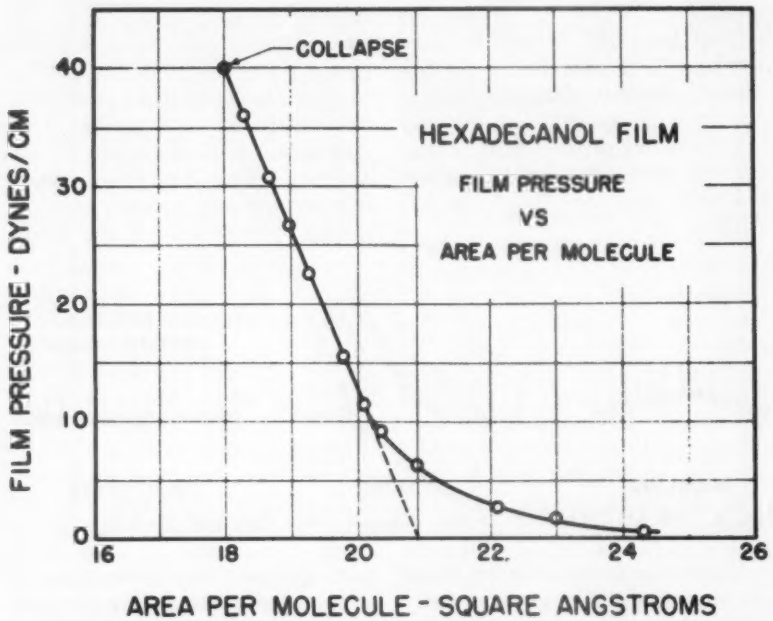


Fig. 4. RESULTS OF LANGMUIR tray test showing film pressure versus area per molecule for hexadecanol film.

During the summer of 1960 the U.S. Bureau of Reclamation, with the cooperation of the U.S. Geological Survey, the U.S. Public Health Service, the Arizona State Fish and Game Department, and the Salt River Valley Water Users' Association performed field tests at Lake Sahuaro forty miles northeast of Phoenix, Arizona. The purpose of these tests was to study the effect of the wind on the film and to develop effective means of applying and maintaining the film.

There have been several other important research programs in the field of evaporation suppression. Grundy with the East Africa Meteorological Organization in Kenya conducted extensive field tests dispensing the chemical as a solution dissolved in a petroleum distillate. W. J. Roberts with the State of Illinois Water Survey used two 3 acre reservoirs of similar characteristics, one serving as a control, the other being dosed with chemical from wire screen rafts. He noted evaporation savings ranging from 22 to 43 per cent with cost of chemicals averaging about $26 per acre-foot of saved water. During one of Roberts' tests an 8 inch rainfall occurred. It broke up the film but after the storm the film reformed from the excess chemical that was present in the water.

In recent years various personnel of the U.S. Public Health Service have made important contributions. Hexadecanol was given an unqualified toxicity clearance by the Robert A. Taft Sanitary Engineering Center, U. S. Public Health Service, Cincinnati, Ohio. Other important research originating at the Sanitary Engineering Center includes that on the bacterial attrition of hexadecanol and the use of bactericides to counteract attrition.

Unique Problems

Many problems arise when one tries to reduce evaporation from reservoirs by chemical means. The biggest problem is wind. Even a gentle breeze will gradually move the film across the water surface. One solution to this problem is to apply the chemical almost continuously to

replace the film that has been blown away. If there is a reversal in wind direction the film will reform, particularly if there is an excess of chemical present. A partial solution to the wind problem is to select a reservoir in an area that is not excessively windy. Also it is possible that windbreaks might be useful.

Application of the Chemical. Many different techniques of administering the chemical have been tried. At ordinary temperatures hexadecanol is a white, waxy solid. It can be ground down to a fine powder or is obtainable in the form of flakes. The material can also be pelletized. Hexadecanol melts at about 130° F. A droplet of fine spray of the molten chemical will solidify to form a bead of the material. The size of the bead can be varied by changing the fineness of the spray. Hexadecanol will dissolve in certain solvents such as petroleum ether and kerosene. Several techniques of administering the chemical are as follows: from wire-screen floats, by hand as a powder or flake, as a mechanical suspension sprayed onto the water surface under pressure, as a solution dissolved in a solvent, application as an emulsion, and sprayed onto the water in a molten condition.

The use of wire-screen floats has been moderately successful on small reservoirs. To be effective, the float density should be at least one every two acres. On large reservoirs it would be totally unfeasible to have so many floats. Moreover they would interfere with boat traffic. In using the float technique the chemical within the screen may be in the form of a large solid chunk or as pellets of a size greater than the screen opening. In using floats there are the problems of screen corrosion, gumming up of the screen openings with bacterial growths, and melting of the chemical if the float is not properly insulated.

Administering the chemical by hand from a boat seems to be one of the most effective means as the chemical can be broadcast in those regions of the water surface where it is needed to replenish the film that has been blown away by the wind. This method is rather costly however because of the high labor charges. Administration by hand from shore stations is generally not effective, for widespread film coverage cannot be achieved. It is possible that the powder could be dispensed from an airplane much in the manner of a crop duster though this would be costly.

Administering the chemical as a mechanical suspension sprayed onto the water surface was the technique used by the Bureau of Reclamation at Lake Hefner in the summer of 1958. Their method involved the use of a boat equipped with a pump and pressure system so that the chemical could be sprayed onto the lake surface wherever needed. From that viewpoint it was a good method; however, labor costs were relatively high. Another technique of application involves the use of plastic pipe with a manifold outlet system to distribute the suspended material. This technique has apparently been successfully applied on small reservoirs where the wind directions are reasonably constant.

Dispensing the chemical as a solution presents several problems. The solvent adds to the cost and even though most solvents are very volatile and evaporate almost instantly some of them are apt to impart an undesirable taste or odor to the water. The technique may prove useful on small reservoirs where floating drip cans can be used though dangers may be encountered because of possible inflammability of some of the solvents. Application of the material as an emulsion may prove successful though there has not been much experience with this method.

Spraying the chemical in the molten condition holds promise as being perhaps the best method of dispensing the chemical. During the summer of 1960 this technique was used at Lake Sahuaro in Arizona and also at Stanford University. In these studies it was observed that good film coverage could not be obtained by dispensing the chemical at a single point. At Lake Sahuaro there were four molten dispensers situated at the shoreline while at Stanford there was a single molten dispenser on a float anchored away from shore. To get good film coverage the mobility of a boat is required so the chemical can be applied in those areas where it is needed. For large reservoirs the best answer to date may be the use of a boat equipped with a dispenser that ejects molten chemical as a fine spray. In all methods there are the problems of aggregation of particles and bacterial growths. These cut down the exposed area of contact between chemical and water resulting in reduced rates of film formation.

Identification of the Film. In research work and also in practical application of the films one must be able to determine whether or not a film is present. The film reduces surface tension and causes a quieting of the microwaves. Immediately after applying the chemical a slick is formed on the water surface which can readily be seen by eye. Thus one means of film identification is visual; however, this technique cannot be relied upon as slicks will form on water surfaces when wind velocities are so low there is not enough energy to create microwaves. A convenient technique of identification is to place a mixture of talcum powder and hexadecanol on the water surface. If the talcum spreads no film is present while no spreading of the talcum indicates the presence of a film. The best technique of identification is the use of indicator oils. These were developed by the Bureau of Reclamation. They consist of a battery of oils made up of varying combinations of a light mineral oil and dodecyl alcohol. The percentage of dodecyl alcohol present in these mixtures influences the spreading pressure. By placing drops of different indicator oils on the water surface it is possible to ascertain if a film is present and if so to measure the film pressure.

Biological Attrition. As previously mentioned the film-forming chemicals are consumed by bacteria at a rate of perhaps 0.2 lb to 0.3 lb per acre per day. To counteract this effect the use of a bactericide is indicated. Several copper compounds have proved effective though more fundamental knowledge of the action of bactericides is needed.

Cost of the Chemical. The cost of the chemical varies considerably. In small lots a good grade of hexadecanol can be purchased at 60 cents per pound. In carload lots the cost is 51.5 cents per pound. During the 1960 program at Lake Sahuaro a combination of octadecanol and hexadecanol costing 25 cents per pound was used. It is possible that new processes of manufacture and greater demand for these chemicals will

lower their cost considerably. One thing that should be kept in mind however is that tests using hexadecanol and octadecanol from different manufacturers have indicated widely varying results in evaporation reduction capabilities. Impurities apparently have a great effect on the film.

Evaluation of Evaporation Reduction. In research work and also in practical application it is important that one be able to evaluate the effectiveness of the film in reducing evaporation. Several methods are available but they will not be discussed in detail here. The techniques of evaluation include the pan coefficient approach, the use of two similar reservoirs (one with film, the other without), and the method proposed by Harbeck. The latter method is a good one though as far as practical application is concerned the instrumentation is expensive.

Editor's Note: References will appear at the end of Part II

Partially Orie

nted on . . .

DIS- *organization*

Man

■ LOTS OF PEOPLE think that once you can get hold of a secretary you change from a mere man to an Organization Man. It is thought that you can't Manage without the aid of a secretary, and the higher up the scale of effective output you aim to go, the more secretaries you will need. I am not so sure this is true. Not having a secretary right at the moment I can see things in a different light.

For instance as I sit here bashing away at the typewriter I can see the words pop up in front of me. That is a convenience because it is not long before I can see whether I am writing sense or nonsense. Of course, from time to time, the typerwirter takes charge, or we don't seem to work in paralalllel for a moment or tow, or maybe during a change of clutch the typewriter falls off the end of the desk because it isn't fastened down—but by and large, with oil in the works and beer in me, we usually get stuff pasted together no worse than the printer has seen before.

In the presence of a secretary, however, I get hitched up by Inhibitions. My executive motivation ability factor seems to suffer a stoppage, and things which once were reasonably stuck together now begin to come apart. Take letter writing for instance. You collect two or three letters together and "ring" for the secretary. (Actually I used to shout because we never got around to fixing up the 6 ft of bellwire required.) You then start dictating, which at first taste seems a splendid occupation for a man with a ready command of English like me. Finishing the first letter, you dictate the next—but, alas, you find you can only dictate half of it, because the other half needs some Facts to go with it, and the Facts are not to hand, so we will leave this letter and get on with the next which is a simple two line acknowledgement.

Finishing that brings the first twinge of creeping disorganization. What to do now? One letter, one half letter, and one two line acknowledgement cannot be said to extend a secretary to her fullest powers of secretaryship for a seven and a half hour day. The secretary agrees; she yawns. True, there are other letters to be answered, but in this unkind profession of ours these are letters which require Thinking About. So the disintegrating Organization Man suggests to his secretary that she go type those she has, while he gets a "couple more ready for after lunch."

Assuming that lunch is not too heavy and some Thinking has been possible, three—even four—letters may be ready by mid-afternoon. Now comes the time for savoring the full delights of dictation. We roll out the phrases, perambulate around the room to pick the happiest parentheses, dive for the dictionary and, unwinding the logic of the situation with remorseless acumen, round upon the conclusion with devastating sagacity. This is good. One by one the letters are dealt an unanswerable blow, and as the typewriter buzzes merrily away in the outer office we can sit and look out of the window, meditating how easily these things come to one with talent. Soon can be heard the clop, clop of the capitals on the envelopes being addressed and then—hey presto—in mark the "Letters for Signature."

One hops behind the desk for a suitable position for the Signing Ceremony. The first one is right. The name is right, the contents right, and the space for signature right. It is a short letter I know, but a taster of good things to come. Let us look at this one now—page and a half. Ah yes, that was a good start. Umm, umm—excellent phrasing. Let me just read that again. That's funny, that wasn't what I said was it? What I meant was . . . . aah, I see what I meant. "Yes, see here Miss, we should have this phrase over here and that phrase over there. Perhaps you wouldn't mind doing just the first page again . . ." Now this one should be all right. "Dash it Miss . . . . *should not be* returned . . . . not *should be* returned. Can we possibly squeeze it in here—oh sorry—I didn't know this pen gave blots. Well perhaps it won't take long to retype?" Now we have this other one. Yes that seems all right. "Hang on Miss while I sign it. Oh dear! Didn't I say 'yours sincerely'? Couldn't you see it started 'Dear Mr.—'? Oh well, I suppose you weren't to know. No! Don't rub it out; that would look Awful. Perhaps you had better leave it for now or we'll be here all night. I'll telephone him in the morning."

CONTINUED ON PAGE 197

ORP limitations in . . .

Activated Sludge Process Control

by BRIAN L. GOODMAN, M.S.P.H.,
Chemist, Sewage Treatment Plant,
Warren, Michigan.

■ THE UTILIZATION of oxidation-reduction potential measurements as a parameter during sewage treatment is not a new idea; neither is the theory and measurement of ORP a recent development. Rohlich, et al, 1941, published the first significant study of the relationship of ORP measurement to sewage treatment control [20]. Numerous articles have since appeared: Eckenfelder & Hood [3 4]; Eliassen [5]; Grune & Chueh [7]; Gruen & Lotze [8]; Hood [10]; Hood & Rohlich [11]; Keefer & Meisel [13 14 15]; Kehoe & Jones [17]; Moore, et al [18]; Nussberger [19]; Rohlich [21 22]; and Shapiro [23].

In order to gain more basic information and a better insight into the activated sludge process and to more effectively control that process at this plant, it was decided to investigate the possibility of study and control of the process by oxidation-reduction potential measurement methods. Following an intensive study of the literature, it was decided to utilize the method advanced by Nussberger [19]. It was felt that the classic tests; i.e., settleable solids, suspended solids, volatile solids, dissolved oxygen, biochemical oxygen demand, nitrate, nitrite, and nitrogen determinations, were not providing the type of information necessary to fully evaluate the process. Further, it appeared that the ORP method offered a much simplified means of process control.

The Nussberger Method

The method advocated by Nussberger, subsequently to be referred to as the *ORP Loss Curve Method,* involves the sealing of a grab sample of aerator effluent in a container together with a platinum and a calomel electrode and, while keeping the sample in suspension with the help of a magnetic stirrer, to take ORP readings at regular intervals, see Fig. 1. For this study the Beckman No. 39271 Platinum Thimble and No. 39170 Calomel electrodes were employed in conjunction with the Beckman Model G and Zeromatic pH meters. The Model G was quickly discarded for this use in favor of the Zeromatic. Since the meter was in such constant use, the battery operated Model G gave considerable difficulty due to weak batteries which lead to erroneous results and a considerable waste of time. The Zeromatic, on the other hand, being a line operated instrument, yielded, with only nominal care, quite reliable results. No difficulty was experienced with the electrodes used in this study.

When the various ORP readings are plotted, a curve is obtained which, according to Nussberger [19], can be characterized as *normal, overloaded, underaerated,* and so forth, see Fig. 2. It was apparent from the beginning that, taken at face value, each curve really contained several elements. For example, a curve might display elements of both overaeration and underloading. It has been concluded [19] that the slope of the curve thus obtained, or, to state it differently, the time it took the ORP level to reach zero, in hours T_z, must be related to the loading of the system, degree of aeration, etc.

Several hundred tests using the ORP Loss Curve Method were conducted at this plant and the curves plotted. An attempt was then made to correlate T_z with the usual parameters of loading such as lbs BOD/1000 cu ft of aerator, lbs BOD/100 lbs mixed liquor suspended solids (MLSS), and so on. No correlation was found, nor was a correlation found with the usual parameters of process efficiency such as per cent BOD removed or lbs BOD/day in the plant effluent.

Theoretically, the lower the value of T_z the higher the aerator loading as judged by some unit as lbs BOD/100 lb MLSS. If a loading of 30 lb BOD/100 lbs MLSS resulted in a T_z value of 1.50 hours, then a loading of 15 lb. BOD/100 lb MLSS should result in a T_z value of something like 3.00 hours. Theoretically, T_z is inversely proportional to the load applied to the aerator or activated sludge system, see Fig. 3. It is entirely possible and even quite probable that this is true when all other factors remain unchanged. Unfortunately, such ideal conditions are found only in rigidly controlled laboratory studies. In actual plant practice, the

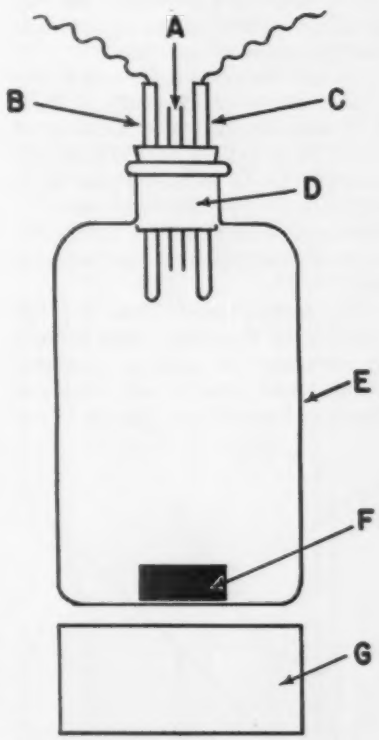


Fig. 1. APPARATUS for determining the ORP loss curve. A, glass tube; B, calomel electrode; C, platinum electrode; D, three-hole rubber stopper; E, one liter wide mouth bottle; F, magnetic bar and G, magnetic stirrer.

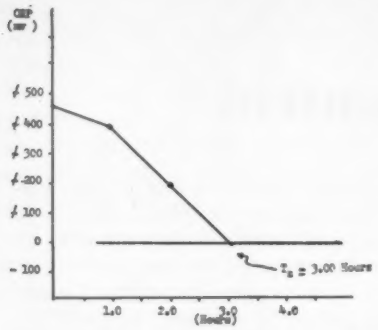


Fig. 2. TYPICAL ORP loss curve. Derivation of T_z from typical ORP loss curves.

composition of the influent raw sewage varies so widely that this factor alone is more than sufficient to invalidate most generalizations. It is elementary that raw sewage is a complex mixture of organic and inorganic substances. The presence of ions such as Cr + 6 in significant concentration in the raw sewage can have a most pronounced effect on the outcome of the ORP Curve Procedure and this is only one ion out of the entire range of possibilities, see Fig. 4. When viewed in this light, simple correlations were not found.

In one series of tests, which was typical of the entire study, a T_z of 1.75 was obtained with loadings of 3, 27, 34, & 53 lb BOD/100 lb MLSS, respectively. In another series, BOD removals of from 74 to 94 per cent were obtained with a T_z of 3.00. Table I gives some typical ranges encountered.

It is entirely possible that the ORP Loss Curve Procedure could be used to advantage at sewage treatment plants which receive only domestic wastes. Numerous papers have pointed out the possibility of using ORP precedures in the detection of industrial wastes and their treatment: Baffa[1]; Eckenfelder & Hood[4]; Greer[6]; Hood & Rohlich[11]; Keefer & Meisel[15]; Kennedy[16]; and Hoot[12]. Other papers have pointed out the effect of pH on ORP readings: Eckenfelder & Hood[3]; Henry[9]; Kehoe & Jones[17]; and Shapiro[23].

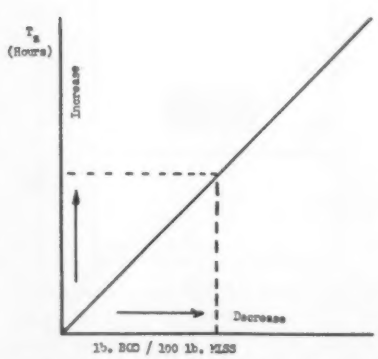


Fig. 3. THEORETICAL relationship of aerator loading to T_z.

Unless the pH of the plant influent remained fairly constant and the influent was free of industrial wastes, it is only to be expected that the usefulness of ORP procedures will be greatly limited, if not ruled out entirely, except as a means to detect such wastes. Sewage entering the treatment plant of the City of Warren contains a large amount of industrial waste. There are more than 600 industries within the city. Among these 600 industries are practically every type of plating operation. Although these industries are controlled and their wastes continuously monitored so that only minor amounts of cyanide and the heavy metals reach the treatment plant, their presence would appear to be a major cause of failure to correlate T_z with plant loading. It must be remembered that not only is it necessary to consider the effect of the heavy metals and the like, but also an infinite number of industrial chemical compounds that are in current use and find their way into the city's sewage system.

In use today is a seemingly endless array of cleaners, solvents, stripping compounds, anti-foam agents, wetting agents, flocculants, disinfectants, and the like. So pronounced are the effects of some of these and so sensitive are the ORP procedures available today, that methods such as the ORP Loss Curve Procedure have been used with some success at this plant to assess the effect of these various materials on activated sludge.

Summary

ORP test methods have been widely advocated for the study and control of waste treatment processes. The results of this study point up some of the limitations of these test methods. It has been shown that industrial wastes seriously limit the use of at least one ORP procedure. The rate at which the ORP level of aerator effluent falls to zero is theoretically inversely proportional to the loading of the present study, due probably to interference by industrial waste.

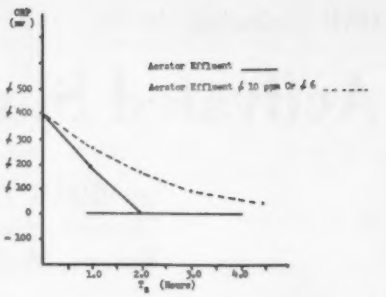


Fig. 4. EFFECT of hexavalent chromium on the outcome of the ORP loss curve procedure.

References

1. Baffa, J. J. "Industrial Waste Instrumentation for Measurement & Control," *Water & Sewage Works*, **101**: 358 (1954).
2. Dawson, P.S.S., & Jenkins, S. H., "The Oxygen Requirements of Activated Sludge Determined by Manometric Methods," *Sewage Works Journal*, **12**: 643 (1949).
3. Eckenfelder, W. W. Jr. & Hood, J. W., "A Critical Evaluation of Routine Sewage Analyses," *Water & Sewage Works*, **97**: 138 (1950).
4. Eckenfelder, W. W. Jr. & Hood, J. W., "The Application of Oxidation-Reduction Potential to Biological Waste Treatment Process Control," *Proc.* of the *Sixth Industrial* Waste Conf., Purdue University, 1951, 221.
5. Eliassen, Rolf, "Oxidants & Reductants in Sewage Plant Effluents & Streams," *Water & Sewage Works*—Ref. & Data Edition, **92**: R211 (1954).
6. Greer, W. N., "Instruments and Their Application in the Control of Industrial Wastes," *Sewage and Industrial Wastes*, **24**: 300 (1952).
7. Grune, W. N., & Chueh, C. "Redox Potentials in Waste Treatment-Laboratory Experiences and Applications," *Sewage and Industrial Wastes*, **30**: 479 (1958).
8. Grune, W. N., & Lotze, T. H., "Redox Potentials in Sludge Digestion," *Water & Sewage Works*, **105**: 37 (1958).

Table I

Range of Aerator Loadings and Values of T_z Showing Lack of Correlation

T_z	Range lb BOD/100 lb MLSS
1.50	6 to 15
2.00	1 to 39
2.50	5 to 74
3.00	8 to 67
3.50	3 to 30
4.00	17 to 36
4.50	3 to 37
5.00	7 to 78

9. Henry, C. R., "Measuring the ORP of Sewage," *Journal Water Pollution Control Federation* **32**: 897 (1960).
10. Hood, J. W., "Measurement and Control of Sewage Treatment Process Efficiency by Oxidation-Reduction Potential, *"Sewage Works Journal,* **20**: 640 (1958).
11. Hood, J. W., and Rohlich, G. A., "Oxidation-Reduction Potentials in Sewage Treatment," *Water & Sewage Works,* **96**: 352 (1959).
12. Hoot, R. A., "Automatic Control of Raw Sewage Chlorination," *Water & Sewage Works,* **96**: 267 (1959).
13. Keefer, C. E. and Meisel, J., "Activated Sludge Studies—I. Effect of Sludge Age on Oxidizing Capacity," *Sewage & Industrial Wastes,* **22**: 1117 (1950).
14. Keefer, C. E. and Meisel, J., "Activated Sludge Studies—II. Efficiency & Performance Under Various Conditions," *Sewage & Industrial Wastes,* **22**: 1518 (1950).
15. Keefer, C. E. and Meisel, J., "Oxidation-Reduction Potential of Chlorinated Sewage," *Sewage & Industrial Waste,* **25**: 759 (1953).
16. Kennedy, R. H., "ORP Theory and Application," *Industrial Wastes,* **5**: 25 (1960).
17. Kehoe, T. J. and Jones, R. H., "ORP Measurement in Waste Treatment," *Water & Sewage Works* **107**: 305 (1960).
18. Moore, W. A. *et al,* "Oxidation-Reduction Studies—I. Oxidation-Reduction Potentials Developed by Pure Cultures in Sewage," *Sewage Works Journal,* **14**: 980 (1942).
19. Nussberger, E. E., "Application of Oxidation-Reduction Potentials to the Control of Sewage Treatment Processes," *Sewage & Industrial Wastes,* **25**: 1003 (1953).
20. Rohlich, G. A. *et al,* "Oxidation-Reduction Potentials in Activated Slduge, A symposium on Hydrobiology, U. of Wisconsin Press, 1941, pp. 288-302.
21. Rohlich, G. A., "Oxidation-Reduction Potential Measurements in Activated Sludge and Activated Sludge-Sewage Mixtures," *Sewage Works Journal,* **16**: 540 (1944).
22. Rohlich, G. A., "Measurement & Control of Sewage Treatment Process Efficiency by Oxidation-Reduction Potential—A Discussion," *Sewage Works Journal,* **20**: 650 (1948).
23. Shapiro, "Oxidation-Reduction Potential," *Water & Sewage Works,* **101**: 185 (1954).

Results of Municipal Water Pollution Control Survey

Dr. Luther L. Terry, Surgeon General of the United States Public Health Service, has announced results of the most comprehensive survey of municipal water pollution control needs ever undertaken. The survey, completed early this year, included 48 States, the District of Columbia, Puerto Rico and the Virgin Islands.

The survey, conducted by the Conference of State Sanitary Engineers, composed of the Chief Engineers of State Health Departments, disclosed that the United States needs approximately 5,200 new sewage treatment plants, plant enlargements, and additions costing $2 billion. These projects are required to treat municipal wastes now being discharged into the Nation's waters from a population of about 42 million.

The USPHS estimates from the survey that these needs, together with new ones resulting from plant obsolescence and population growth, will carry an annual price-tag of about $600 million. This would represent a 40 per cent increase in national construction of sewage treatment facilities.

Arkansas Water Pollution Control Commission Annual Progress Report 1959-1960

The Arkansas Water Pollution Control Commission completed comprehensive basin surveys covering 2,945 square miles and 35 waste treatment plants during the fiscal year 1959-1960, according to the Commission's Annual Progress Report.

Other actions by the Commission included collecting 1,163 water and waste samples and performing 8,352 laboratory analyses. Stream basin surveys covering 1,100 square miles were intiated and two public hearings were held concerning sources of pollution. Three court injunctions were obtained during the year for violations of water pollution control laws.

The commission issued 68 permits for oil field brine disposal systems and issued 12 permits for construction of industrial waste treatment facilities. Twelve permits were also issued for construction of municipal sewage treatment works.

Construction grant funds totaling $593,336 were certified by the Commission for municipal sewage treatment works construction costing a total of $2,576,322.

Polyethylene Plastic Pipe Standard Issued

A printed edition of Commercial Standard CS197-60, *Flexible Polyethylene Plastic Pipe* is now available. The revised Commercial Standard covers requirements for material, workmanship, dimensions, working pressure, field pressure, incremental pressure, sustained pressure and environmental cracking for three types of resin, as well as one schedule and two series of polyethylene pipe, used principally for conveying potable water. Methods of marking and indicating compliance with this Standard are included.

The revision was initiated by The Society of the Plastics Industry, Inc., and has been endorsed by a representative cross-section of the industry. Copies may be purchased from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C., price 15 cents.

Vitrified Clay Sewer Pipe Standard Issued

A printed edition of Commercial Standard CS224-60, Vitrified Clay Sewer Pipe is now available. The Standard provides a primary reference to existing nationally recognized specifications for standard strength and extra strength vitrified clay sewer pipe. A means of indicating compliance with the Standard is included.

The Standard was initiated by The National Clay Pipe Manufacturers, Inc., and has been endorsed by a representative cross-section of the industry. Copies may be purchased from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C., price 10 cents.

The water pressure is terrific in this town.

RESEARCH PROGRESS REPORT

Algae Growth Rate

by WESLEY O. PIPES, JR.
Assistant Professor of Civil Eng.
Northwestern Univ., Evanston, Ill.

■ THE ECOLOGICAL RELATIONSHIPS of any biological waste treatment process are undoubtedly complex. Since a stabilization pond depends upon the presence of autotrophic organisms as well as heterotrophs for proper operation, it is biologically more sophisticated than the other conventional treatment processes.

It has been postulated [1] that in a stabilization pond the heterotrophic organisms, bacteria, fungi, and protozoa, oxidize waste organic matter excreting carbon dioxide, ammonia, and other inorganic compounds which may serve as nutrients for the algae present. In turn, the algae produce oxygen for the heterotrophs as a by-product of photosynthesis. This hypothesis, although valuable as a starting point for discussions of the ecology of stabilization ponds, is a simplification of the actual situation.

It has been known for some time [2] that many of the algae, notably Chlorella and Scenedesmus, which often occur in stabilization ponds, are able to utilize a variety of organic compounds as carbon sources, nitrogen sources, or energy sources. More recently it has been reported that under certain cultural conditions *Chlorella pyrenoidosa* will reduce the concentration of organic material in sewage when grown in the absence of bacteria [3]. Thus some of the algae in a stabilization pond are able to utilize some of the waste organic matter directly. Whether or not this actually occurs and what effect it would have on the growth of the algae has not been established previously.

This investigation was a study of the effect of some organic materials, both pure organic compounds and organic matter extracted from sewage, on the growth rate of an alga which commonly occurs in stabilization ponds. It was designed to provide information which might indicate if stabilization pond algae do actually assimilate organic matter from waste waters, the growth conditions under which this assimilation might take place, and what effect it would have on algal growth.

Methods

The test organism used in this series of experiments, is a strain of *Chlorella pyrenoidosa* which was isolated from a stabilization pond. It is the same strain which was used in previous experiments to determine if organic matter from sewage could be assimilated by algae [3].

The technique of testing was to determine the growth rate of *Chlorella pyrenoidosa* grown on an inorganic medium and, at the same time, the growth rate of the alga in cultures to which the test material has been added. The growth rate was measured by determining the packed cell volume at two different times during the period of active growth and calculating the growth constant, k_g, from the formula:

$$K_g = 1/t \log V_o/V_t,$$

where t is the time of growth, V_o is the initial packed cell volume, and V_t is the packed cell volume at time t [4].

The inorganic medium used in this investigation was a modified Knop's solution containing 722 mg KNO_3, 44 mg KH_2PO_4, 75 mg $MgSO_4$, 3.6 mg $Fe_2(SO_4)_3$, 1.4 mg $CaCl_2$, 5.4 mg H_3BO_3, 1.24 mg $ZnSO_4$, 1.36 mg $MnSO_4$, .75 mg MoO_3, 1.26 mg $CuSO_4$, and 1.1 mg $CoCl_2$ per liter. It contains all of the nutritional requirements for *Chlorella pyrenoidosa* in concentrations which would allow the alga to attain its maximum growth rate when the physical conditions are optimum [5]. Carbon dioxide was provided by aerating the cultures with either compressed air or air enriched with 1 per cent CO_2. It was assumed that carbon dioxide was limiting in the cultures aerated with air, but that the carbon dioxide concentration was not limiting algal growth when the cultures were aerated with 1 per cent CO_2 in air.

The cultures were illuminated by forty-watt, soft white, fluorescent lights. The light intensity at the surface of the cultures was between 175 and 200 foot candles. During the tests the cultures were maintained at a temperature of 25°C ± 2°.

Several groups of pure organic compounds were tested to determine their effect on the growth rate of *Chlorella pyrenoidosa*. The compounds were selected to provide representatives of several types of compounds which are metabolized by many groups of microorganisms. Preliminary tests were carried out in open cultures in which no attempt to exclude bacteria was made. Those compounds which seem to have an effect on the growth rate of the alga were then tested in sterile cultures aerated with air and in sterile cultures aerated with 1 per cent CO_2 in air.

The sewage which provided organic material for some of the tests was collected from a sewage treatment plant which treats primarily domestic sewage. The samples were collected on weekday mornings during a dry period. Eight samples were collected over a two week period to provide a composite sample. A portion of each sample was autoclaved and stored. The remainder of each sample was run through an extraction process which provided six concentrated fractions of the organic material present. The extraction procedure is diagrammed as a flow sheet in Figure 1.

In the process of extracting the ether solution, amorphous precipitate was formed. Apparently, this precipitate was either soap, detergent, or the product of the saponification of some fats which were extracted from the sewage. It was retained with the aqueous layer throughout the rest of the extraction procedure but showed no tendency to re-dissolve in either the aqueous solution or in the ether. It was finally separated by filtration and labelled fraction *S*.

Results

The results of the preliminary tests indicated a variety of compounds which might increase the growth rate of *Chlorella pyrenoidosa* under some conditions. All of these compounds were tested in pure cultures. The compounds which did not alter the growth rate of the alga in open cultures with inadequate CO_2 were assumed to be inactive as far as the nutrition of *Chlorella* was concerned. Among the compounds tested and found to be inactive were aliphatic alcohols and amines and aromatic carboxylic acids. Of the fatty acids tested, those with six or more carbon atoms had no effect on the growth rate of *Chlorella*.

The results of the tests of organic compounds in pure cultures which were aerated with air are presented in Table 1. Most of these compounds showed some indication of having an effect on the growth rate. The greatest acceleration of growth was given by nitrogen containing compounds such as amino acids, urea, and yeast extract. Since the algae in this culture did not have adequate carbon dioxide, it is probable that these compounds served as sources of both carbon and nitrogen. However, several of the other compounds which accelerated the growth rate could only serve as carbon sources.

The compounds which were found to accelerate the growth rate of *Chlorella pyrenoidosa* in pure cultures where the concentration of carbon dioxide was inadequate were tested in pure cultures having adequate carbon dioxide. The results of these tests are presented in Table 2. Many of the compounds which could serve as nitrogen sources or as sources of both carbon and nitrogen accelerated the growth rate, although the percentage increase was not as great as in the cultures in which the carbon dioxide concentration was inadequate.

The results of the experiments in which the effect of the various fractions of the organic matter extracted from sewage on the growth rate of *Chlorella pyrenoidosa* was determined are presented in Tables 3 and 4. For these tests the organic material from sewage was diluted with the inorganic medium until the concentration in the test cultures was approximately equal to the concentration in the sewage. The experiments whose results are reported in Table 3 were carried out in cultures which were aerated with air, and thus any acceleration of growth may be interpreted in terms of the assimilation of organic carbon. From these data it is apparent that the compounds present in sewage which may serve as carbon sources for *Chlorella* are those which are more soluble in water than in ether and those which form salts in a basic solution. The same compounds could be responsible for the activity of fraction *B* and fraction *C* since the difference in solubility in hydroxide and in bicarbonate solution of many organic compounds is not clear cut.

Table I

Tests of Organic Compounds in Sterile Cultures with Inadequate Carbon Dioxide Supply

Compound	Concentration			
	0	10^{-5}M.	10^{-4}M.	10^{-3}M.
	Growth Rate			
Glucose	0.352	1.094	0.912	0.589
Acids				
Formic	0.348	0.332	0.508	0.418
Acetic	0.364	0.328	0.492	0.392
Oxalic	0.354	0.856	0.644	0.490
Malonic	0.370	0.872	0.718	0.444
Tartaric	0.366	0.880	0.708	0.405
Succinic	0.348	0.862	0.734	0.370
Pyruvic	0.356	0.882	0.688	0.462
Lactic	0.344	0.868	0.708	0.424
Citric	0.364	0.892	0.876	0.514
Amino Acids				
Glycine	0.344	0.942	0.888	0.422
Alanine	0.366	0.878	0.818	0.388
Glutamatic acid	0.377	0.898	0.900	0.502
Tryptophan	0.348	0.846	0.814	0.464
Phenylalanine	0.360	0.875	0.718	0.443
Miscellaneous				
Hydrolysed Casein	0.375	0.734	0.688	0.418
Yeast Extract	0.354	0.600	0.578	0.348
Ascorbic acid	0.368	0.922	0.824	0.446
Urea	0.368	0.902	0.898	0.512
Uric acid	0.374	0.454	0.432	0.378

The results of the tests in cultures supplied with 1% CO_2 in air are presented in Table 4. The only definite acceleration of growth occurred in the sewage itself and in the fraction containing water soluble compounds. The acceleration was greater in the whole sewage than in the sewage which had been extracted with ether, possibly indicating that some but not all of the active materials had been removed by extraction with ether.

Included in these two series of experiments were two tests of the effect of fresh urine on the growth rate of *Chlorella pyrenoidosa*. Since a preliminary experiment indicated that this alga would not grow in fresh urine, the sample was diluted 1:10 with the inorganic medium before any of the cultures were made up. Thus the dilutions indicated in the table should be divided by ten to give the actual dilution. Urine gave good acceleration of growth in all cultures in which it was tested. Assuming a urine output of 1 quart per

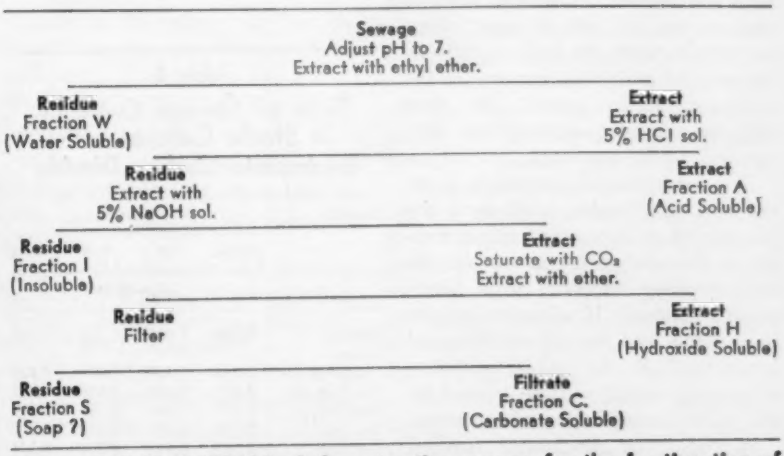


Fig. 1. FLOW DIAGRAM of the extraction process for the fractionation of the organic compounds of sewage.

Table 2

Tests of Organic Compounds in Sterile Cultures with Inadequate Carbon Dioxide Supply

Compound	Concentration			
	0	10^{-3}M.	10^{-4}M.	10^{-5}M.
	Growth Rate			
Glucose	1.400	1.490	1.460	1.465
Acids				
Formic	1.390	1.015	1.344	1.385
Acetic	1.410	1.180	1.380	1.390
Oxalic	1.460	1.410	1.385	1.395
Malonic	1.345	1.380	1.390	1.360
Tartaric	1.370	1.355	1.340	1.385
Succinic	1.400	1.385	1.385	1.385
Pyruvic	1.390	1.355	1.380	1.380
Lactic	1.360	1.360	1.380	1.355
Citric	1.385	1.370	1.370	1.390
Amino Acids				
Glycine	1.440	1.670	1.655	1.410
Alanine	1.385	1.595	1.610	1.510
Glutamatic acid	1.390	1.700	1.670	1.455
Tryptophan	1.360	1.655	1.670	1.420
Tyrosine	1.385	1.720	1.690	1.385
Miscellaneous				
Hydrolysed Casein	1.410	1.690	1.620	1.410
Yeast Extract	1.340	1.460	1.455	1.410
Ascorbic acid	1.385	1.390	1.380	1.410
Urea	1.385	1.860	1.860	1.390
Uric acid	1.370	1.440	1.410	1.390

person per day and a sewage flow of 80 gallons per capita per day, the urine present in sewage will be diluted about 1:400. The tests indicated that a dilution of 1:1000 urine stimulated the growth of *Chlorella* as much as did raw sewage alone.

Discussion

A stabilization pond is a type of continuous culture in which both heterotrophic and autotrophic organisms are present. Since the pond is open to the air and, in most cases, in contact with the soil, it will be innoculated with all organisms in the environment. In general, the flow rate and the composition of the sewage will not be constant.

The heterotrophic organisms present in a stabilization pond serve the purpose of oxidizing the organic matter of the sewage to carbon dioxide and releasing ammonia from nitrogenous material. If adequate oxygen is available and the pH of the pond is not too high, the rate of oxidation of organic matter will be limited by the BOD concentration of the pond.

According to conclusions reached by Oswald and Gotaas [1], carbon is most often the factor limiting the growth of algae in high rate stabilization ponds. In conventional oxidation ponds with long detention periods, the limiting factor may be either nitrogen or phosphorus, since there is more opportunity for carbon dioxide to be dissolved from the atmosphere. However, if the detention period of the pond is less than seven days, the concentrations of nitrogen and phosphorus in the pond will generally be greater than 1 mg/l. The very high pH values reached in high rate stabilization ponds is another indication that carbon dioxide is often limiting.

From the above considerations it is apparent that in a stabilization pond the growth rate of the algae most likely will be limited by the carbon dioxide concentration, at least when adequate light is available for photosynthesis. During periods of high light intensity, the photosynthetic rate will increase, increasing the rate of carbon dioxide uptake. The pH of the pond will also increase, but organic matter oxidation rate by the heterotrophs will decrease. It appears unfortunate that the period of greatest oxygen production due to high light intensity will coincide with decreased bacterial activity due to pH limitation.

The algae growing in a sewage stabilization pond will have contact with a certain amount of organic material in the pond. If the growth and metabolism of the bacteria present are limited by the pH of the pond, it is possible that appreciable concentrations of some organic compounds will accumulate. The results of these experiments indicate that *Chlorella pyrenoidosa*, a species of algae frequently found in sewage stabilization ponds, is able to utilize some of the organic compounds that are present in sewage. The results indicate that organic acids, some organic nitrogen compounds, and some vitamins will accelerate the growth rate of this alga, if the concentration of carbon dioxide in the culture is limiting. In a stabilization pond with a low CO_2 concentration, it is quite likely that the algae present will utilize organic matter from the sewage in addition to photosynthetically produced carbohydrates for the production of new cell material.

Table 3

Tests of Sewage Organics in Sterile Cultures with Inadequate Carbon Dioxide

Material	Dilution			
	Control	1:0	1:10	1:100
	Growth Rate			
Sewage	0.364	1.065	0.722	0.384
Urine (diluted 1:10)	0.348	1.100	1.030	0.866
Fraction W	0.372	0.889	0.646	0.397
Fraction A	0.375	0.368	0.354	0.368
Fraction I	0.368	0.298	0.348	0.372
Fraction H	0.362	0.464	0.368	0.374
Fraction S	0.365	0.386	0.375	0.354
Fraction C	0.352	0.512	0.408	0.366

Table 4

Tests of Sewage Organics in Sterile Cultures with Adequate Carbon Dioxide

Material	Dilution			
	Control	1:0	1:10	1:100
	Growth Rate			
Sewage	1.370	1.870	1.580	1.490
Urine (diluted 1:10)	1.385	2.240	2.080	1.880
Fraction W	1.390	1.680	1.520	1.410
Fraction A	1.370	1.360	1.370	1.385
Fraction I	1.420	1.120	1.240	1.320
Fraction H	1.360	1.470	1.380	1.395
Fraction S	1.380	1.310	1.360	1.420
Fraction C	1.390	1.370	1.410	1.360

Experimental results reported herein indicate that the organic compounds of sewage that are utilized by algae as additional sources of carbon are either in the water soluble group or in the base soluble group. The water soluble compounds that are active in the nutrition of the algae are most likely to be polyfunctional compounds such as carbohydrates and hydroxy acids or nitrogenous compounds such as urea, amino acids, and other products from the breakdown of proteins. The base soluble compounds are most likely to be carboxylic acid.

Conclusions:

1. Several types of organic compounds such as sugars, acids, amino acids, and some nitrogenous compounds will accelerate the growth rate of *Chlorella pyrenoidosa* when the rate of photosynthesis is limited by the concentration of carbon dioxide indicating that these compounds may be used as additional carbon sources.
2. Some organic nitrogen sources will accelerate the growth rate of

Chlorella pyrenoidosa above that attained on inorganic media even when carbon dioxide is not limiting.

3. Some of the organic compounds commonly found dissolved in sewage will accelerate the growth rate of *Chlorella* when carbon dioxide is limiting, indicating that some of these compounds may serve as additional carbon sources.
4. Some of the organic compounds of sewage will accelerate the growth rate of *Chlorella pyrenoidosa* when adequate carbon dioxide is supplied.
5. In a stabilization pond it is probable that many of the algae present utilize dissolved organic compounds directly as carbon and/or nitrogen sources.

Acknowledgment

This research was supported in part by a research grant from the Divisions of Research Grants, National Institutes of Health.

References

1. Gotaas, H. B. and Oswald, W. J., "Photosynthesis in Sewage Treatment", ASCE Proceedings Separate 686, Vol. 81, *Transactions ASCE* (1957).
2. Bristol-Roach, B. M., "On the Carbon Nutrition of Some Algae Isolated From Soil", *Ann. Botany* (London) **41**: 509-517 (1927).
3. Pipes, W. O. and Gotaas, H. B., "Utilization of Organic Matter by Chlorella Grown in Sewage", *Applied Microbiology* **8**: 163.
4. Meyers, J., "Growth Characteristics of Algae in Relation to Problems of Mass Culture", *Algae Culture from Laboratory to Pilot Plant*, Carnegie Institution of Washington Publication 600, Washington, D. C. 37-54 (1953).
5. Myers, J., "Physiology of the Algae", *Ann. Rev. of Microbiology* **6**: 157-180 (1951).

Research on Chemistry of Iron in Natural Water Published

Chemical and biochemical aspects of the behavior of iron in natural surface and underground waters are summarized in U.S. Geological Survey Water-Supply Paper 1459 parts A-I, the first seven parts of which have now been published. Among the topics considered in the nine reports are relationships among dissolved iron, redox potential and other dissolved substances, under conditions of chemical equilibrium in natural water, nature of organic complex ions containing iron, adsorption of foreign ions by precipitates of iron oxide, and circulation of iron in lakes and reservoirs as related to aquatic plants and microbiota.

Results now available show that iron in natural water apparently follows closely the behavior that can be predicted from chemical thermodynamics and that the iron content and pH of underground water indicate the approximate redox potential of the water in its natural state. Although oxidation of dissolved iron to nearly insoluble ferric hydroxide is rapid at near neutral pH, the formation of organic complexes, such as a ferrous-tannic acid complex studied in the research work, may slow the rate of iron oxidation considerably. Precipitated ferric hydroxide has some adsorption capacity, either for anions or for cations depending on the pH of the solution in which the precipitate forms. The hydroxide is positively charged below about pH 5.5 and negatively charged at higher pH.

The research work was done by Geological Survey chemists at Denver, Colorado. Titles of the individual parts of Water-Supply Paper 1459 now available are:

A. "Survey of ferrous-ferric chemical equilibria and redox potentials," by J. D. Hem and W. H. Cropper.
B. "Restraints on dissolved ferrous iron imposed by bicarbonate, redox potential and pH," by J. D. Hem.
C. "Some chemical relationships among sulfur species and dissolved ferrous iron," by J. D. Hem.
D. "Complexes of ferrous iron with tannic acid," by J. D. Hem.
E. "Coprecipitation effects in solutions containing ferrous, ferric and cupric ions," by J. D. Hem and M. W. Skougstad.
F. "A survey of pertinent biochemical literature," by E. T. Oborn.
G. "Iron content of selected water and land plants," by E. T. Oborn.

Copies of the papers may be obtained from the Superintendent of Documents, Washington, 25, D. C., (for 15c each, except F which sells for 30c).

Among the volumes available from the Superintendent of Documents at prices noted include the following states:

Region III: District of Columbia, Kentucky, Maryland, North Carolina, Virginia, West Virginia, Puerto Rico, Virgin Islands; 65c.

Region IV: Alabama, Florida, Georgia, Mississippi, South Carolina, Tennessee; 60c.

Region VI: Iowa, Kansas, Minnesota, Missouri, Nebraska, North Dakota, South Dakota; 70c.

Region VIII. Colorado, Idaho, Montana, Utah, Wyoming; 40c.

Crowther Becomes Pratt President

Henry Pratt Co., Chicago, Ill., recently announced the appointment of Mr. Fred D. Crowther as President.

Mr. Crowther was with the General Electric Company for 26 years where he served as marketing Manager and as Consultant-Organizations Practices. More recently, Mr. Crowther was Vice President and General Manager of The Chapman Valve Manufacturing Company.

Mr. E. B. Cottingham will become Chairman of the Board of Directors.

East Chicago Sanitary District Booklet

The Board of Sanitary District Commissioners of East Chicago, Indiana, has prepared a treatise on the history and modern developments within the Sanitary District and the Sewage Treatment Plant.

Presented in an attractive booklet, the treatise reports that the Sanitary District was scheduled to assume the responsibility of sewer maintenance on January 1, 1961. This job was previously conducted through the sewer division of the East Chicago Street Department.

This change-over would bring all functions of sewage disposal under the supervision of the District and is intended to increase efficieny economically.

Flow Velocity in Partly Filled Pipes

by RICHARD POMEROY
Pomeroy and Associates
Civil and Chemical Engineers
Pasadena, California

■ IT IS IMPORTANT, for a variety of purposes in the sanitary engineering field, to be able to calculate velocity and flow conditions in sewers running less than full. The equation which has come to be known as Manning's is most commonly used for this purpose. This equation rests upon the classical assumption that velocity can be calculated as a function of R, S, and a friction coefficient. This basic assumption is an approximation when streams of different shape of cross section are considered.

The exponent ⅔ for R in the Manning equation does not have a theoretical basis, and has been established as a rough empirical approximation from data on various kinds of open channel flow. Although the equation has been very useful, one should not lose sight of the fact that it has only a weak and incomplete theoretical justification and little empirical support as far as its application to sewers is concerned.

In this study, an equation was sought which would represent such experimental data as are available and would simplify calculations of relative velocities and quantities of flow. Only pipes of circular cross section are considered.

General Equation Relating V and Q

It has been found that the relationship between V and Q in sewers of circular cross section can be well represented by the general formula:

$$\frac{V}{V_F} = m\left(\frac{Q}{Q_F}\right)^w \qquad (1)$$

A synopsis of extensive data on flow in partly filled sewers was made by Camp [1], who described the results graphically. Selection of constants for Equation 1 for best fit to Camp's curves gives:

$$\frac{V}{V_F} = 1.053\left(\frac{Q}{Q_F}\right)^{0.29} \qquad (2)$$

To show the closeness of fit, Table 1 was prepared in which velocity ratio was calculated for various depths of flow. It was necessary to prepare a carefully interpolated series of values from Camp's curves to even demonstrate the trend of deviations. Over a range of flow ratio from 1 to 100 per cent, at 90 per cent depth ratio, the differences between the calculated and empirical results are less than 2 per cent. From 90 to 100 per cent depth ratio, there is an unstable region in which the calculated Q is greater than that for a full pipe. Under ideal conditions, this 100 per cent plus flow can be attained, but it probably rarely happens in a sewer in use except on a backwater curve. Equation 2 actually gives a good approximation of flow well into this range but misses the point of full flow by 5.3 per cent; i.e., by m-1.

Straub and Morris [2] conducted very careful tests under laboratory conditions in concrete pipes of 18, 24, and 36 in. diameter at a slope of 0.002. Experiments on partial flow were made only with the 18 and 24 in. pipes. When flowing full the 18 and 24 in. pipes yielded a Manning n value of 0.0100 when the hydraulic gradient was 0.002, as determined by interpolation from data in the reference cited. Fig. 1 shows the n values found at various depth ratios when the pipes were flowing partly filled.

These data also can be well represented by Equation 1, and the same value of 0.29 for the exponent w is satisfactory, but m is different. The dotted line on Fig. 1 shows apparent n values for the Manning equation assuming that velocity conforms to the equation:

$$\frac{V}{V_F} = 1.147\left(\frac{Q}{Q_F}\right)^{0.29} \qquad (3)$$

Table 1

Comparison of Equation 2 with Camp's Data

Depth Ratio d/D	Flow Ratio Q/Q_F	Velocity ratio Empirical Camp's curves	Velocity ratio Calculated, Equation 2
0.05	0.004	0.218	0.210
0.10	0.017	0.326	0.322
0.15	0.038	0.410	0.410
0.20	0.069	0.482	0.485
0.30	0.153	0.604	0.613
0.40	0.265	0.711	0.719
0.50	0.403	0.805	0.810
0.60	0.556	0.887	0.884
0.70	0.716	0.957	0.955
0.80	0.868	1.010	1.010
0.90	0.998	1.052	1.052

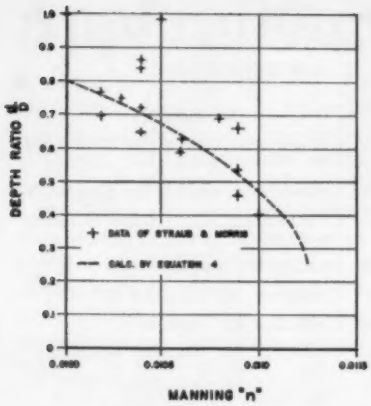


Fig. 1. COMPARISON of data of Straub and Morris with calculations from Equation 4.

The apparent n values are obtained by combining Equations 3 with the Manning equation, giving:

$$\frac{n}{n_F} = (1.147)^{-1.41}\left(\frac{R}{R_F}\right)^{2/3}\left(\frac{A}{A_F}\right)^{-0.41} \quad (4)$$

Except for the point representing a full pipe and three points in or close to the unstable flow range, which is upward from 0.85 depth, the dotted line is a good fit for the data. It shows that Equation 3 represents the data much better than does the Manning equation in which n is a constant.

If it were assumed that the Manning equation did represent velocity in the partly filled pipe, an equation of the form of Equation 1 would still be a fair alternative with m = 1.20 and w = 0.29. The Manning equation would predict a relative velocity about 7 per cent lower than this equation at a depth ratio of 0.80, approx. 100 per cent of capacity; 5 per cent higher at a depth ratio of 0.20, and 3.6 per cent lower at a depth ratio of 0.02. Since the purpose of this study is to deduce an equation which represents observed flow, the value of 1.20 for the constant m required to make Equation 1 approximate the Manning equation, is not given weight in the subsequent considerations.

From the experimental data, it appears that the m value for Equation 1 may be between 1.05 and 1.15. It is expected there will eventually be more experimental data to serve as a basis for choosing the value of m. The utility of the equation is not materially reduced by the present uncertainty about the m value. This only serves to relate the velocity at partial flow to velocity at full flow, which is a matter of subsidiary concern.

Developments from the Basic Equation

For the present, the basic equation will be written:

$$\frac{V}{V_F} = m\left(\frac{Q}{Q_F}\right)^{0.59}$$

Cross section area of a stream is related to other quantities as follows:

$$\frac{A}{A_F} = \frac{Q}{Q_F} \div \frac{V}{V_F}$$

$$\frac{A}{A_F} = \frac{Q}{Q_F} \div m\left(\frac{Q}{Q_F}\right)^{0.59} = \frac{1}{m}\left(\frac{Q}{Q_F}\right)^{0.71} \quad (5)$$

$$\frac{Q}{Q_F} = \left(m \times \frac{A}{A_F}\right)^{1.41} \quad (6)$$

$$\frac{V}{V_F} = m^{1.41}\left(\frac{A}{A_F}\right)^{0.41} \quad (7)$$

Since the depth ratio, d/D, is geometrically related to A/A_F, the foregoing equations can be used in calculating the hydraulic elements at various relative depths of flow, provided a value is selected for m.

In order to calculate a specific rather than relative velocity, it is necessary to choose an equation for flow in the full pipe. The equation of Hazen and Williams is widely used for this. It is commonly written:

$$V = 1.318\ C\ R^{0.63}S^{0.54}$$

Studies by Scobey [3] on various kinds of pipes gave exponents for R of 0.58, 0.625, and 0.65, and exponents for S of 0.5, 0.53 and 0.555. From the report by Straub and Morris [2], it is calculated, on the basis of their Fig. 5, that the exponent of S is 0.56 for the 18 in. pipe and 0.54 for the 36 in. pipe. The exponent of R cannot be determined very precisely from the data, since there is only a two-fold range of R, but it appears to be about 0.60. The Hazen-Williams equation for full pipes seems to be well substantiated.

Derivation of a specific velocity equation for the partly filled pipe is as follows. From the Hazen-Williams equation:

$$V_F = 0.5503\ C\ D^{0.63}\ S^{0.54}$$
$$\text{and } Q_F = 0.4322\ C\ D^{2.63}S^{0.54}$$

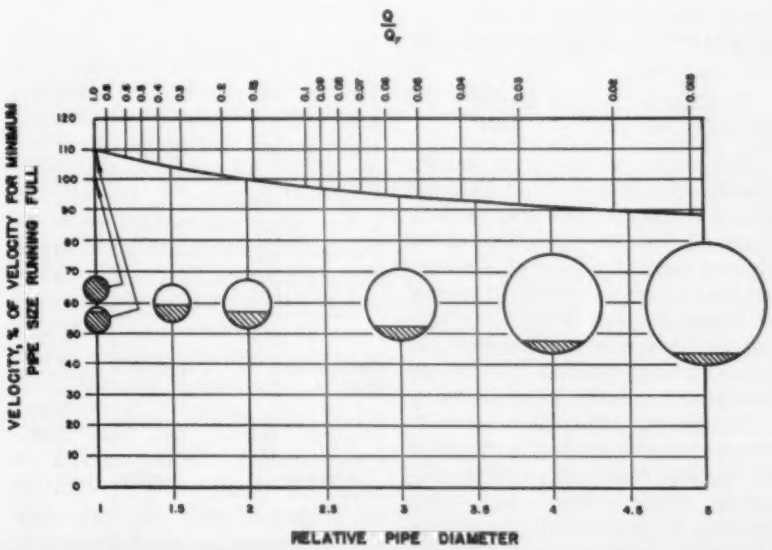


Fig. 2. COMPARATIVE velocities for same flow of sewage in pipes of various sizes.

Substituting these expressions in Equation 1, with w = 0.29:

$$\frac{V}{0.5503\ C\ D^{0.63}S^{0.54}} = m\left(\frac{Q}{0.4322\ C\ D^{2.63}S^{0.54}}\right)^{0.29}$$

$$V = 0.702\ m\ C^{0.71}\ Q^{0.29}\ S^{0.08}\ D^{-0.13}$$

Letting $k = 0.702\ m\ C^{0.71}$ (8)

$$V = k\ Q^{0.29}\ S^{0.08}\ D^{-0.13} \quad (9)$$

Use of this equation obviously must be confined to flows which are less than the capacity of the full pipe. If a Q is used which exceeds the capacity, a fictitious value of V is obtained.

The factor k is a function of the smoothness or roughness of the pipe. Values of this constant must be selected on the basis of experience with the kinds of sewers or other pipes under consideration. If the empirical basis for k is data from partly filled sewers, then the value of m is irrelevant as long as use of the equation is confined to these conditions.

It is interesting to note that velocity is not greatly affected by pipe size, decreasing only as the 0.13 power. Fig. 2 shows relative velocities in pipes of various relative sizes. In this calculation, m is assumed to be 1.10.

For the same S and Q, water in a full pipe flows at the same velocity as in a pipe of twice the diameter, flowing at 0.3 depth. There is however a range of greater velocities at intermediate sizes. Except for this comparison with a full pipe, enlargement of a pipe sufficiently to double the capacity decreases the velocity 3½ per cent.

The conclusion that diameter has a relatively small effect is not dependent upon the equations here deduced. If a similar figure is prepared on the assumption that the Manning equation is valid, there is a maximum of velocity in the vicinity of a diameter about one and a half times the minimum diameter, but the total range of change is about the same.

It is interesting to note that velocity, for any given Q, is not proportional to reciprocal n, but to its 0.71 power. This is because a change of n is balanced by a change of both V and A. Similarly, V, for any given Q, does not vary as the square root of S, but as the 0.38 power of S.

A subsequent paper will present results of a survey of k values of sewers in use.

Summary

The following equation has been deduced for calculating velocity of flow in a partly filled pipe of circular cross section.

$$V = k\ Q^{0.29}\ S^{0.08}\ D^{-0.13}$$

This equation conforms to available data better than the Manning equation.

The value of k is related to the Hazen-Williams coefficient by the equation $k = 0.702\ m\ C^{0.71}$ in which m is approximately 1.10.

Symbols

- A Cross-section area of the stream, sq ft
- A_F Cross-section area of the pipe, sq ft
- C Coefficient for Hazen-Williams equation.
- D Diameter of pipe, ft.
- k Coefficient for Equation 9.
- m Coefficient for Equation 1.
- n Coefficient for Manning equation.
- n_F Coefficient for Manning equation at full flow.
- Q Flow, cfs
- Q_F Flow of full pipe, cfs
- R Hydraulic radius, ft.
- R_F Hydraulic radius of full pipe, or D/4, ft.
- S Slope ratio.
- V Velocity, fps.
- V_F Velocity at full flow, fps.
- w Exponent for Equation 1.

References

1. Camp, Thomas R., "Design of Sewers to Facilitate Flow." *Sewage Works Journal*, **18**:3 (1946).
2. Straub, Lorenz G., and Morris, Henry M., "Hydraulic Tests on Concrete Culvert Pipes." Technical Paper No. 4, Series B, St. Anthony Falls Hydraulic Laboratory, University of Minnesota.
3. "The Flow of Water in Wood-stave Pipe." *U. S. Dept. of Agr. Bull.* 376, (1916), rev. (1926); "The Flow of Water in Concrete Pipe," *U. S. Dept. Agr. Bull.* 852, (1920); "The Flow of Water in Riveted-steel and Analogous Pipe," *U. S. Dept. Agr. Tech. Bull.* 150, (1930).

CHEMISTRY FOR SANITARY ENGINEERS

By Clair N. Sawyer McGraw-Hill Book Co., Inc., 367 pp; 1960

The author, an Associate and the Director of Research of Metcalf and Eddy, Engineers, has been a Professor of Sanitary Chemistry at the Massachusetts Institute of Technology for 15 years. Prior to that period he taught at New York University and the University of Wisconsin; so he is certainly qualified to write on chemistry for sanitary engineers.

His writing has been adapted to present-day practice in the education of sanitary engineers, wherein the average student takes an undergraduate degree in civil engineering (including perhaps one year of chemistry) and then "majors" in sanitary engineering at the graduate level. Sawyer's book provides a review of the principles of chemistry that will be useful to the sanitary engineer, and that he may have forgotten in the time elapsed since freshman chemistry. It also provides a description and explanation of the practical applications of chemistry in sanitary analysis. The book is divided into two main parts for this purpose.

About half of the book is devoted to fundamentals of chemistry for engineers, including concepts from general, qualitative, quantitative, physical, colloid, bio, and radiochemistry. The explanations are clear, and should cause no difficulty to a student who has previously studied chemistry, even though he may have forgotten much of it.

The second portion of Sawyer's book describes the major analytical test useful in sanitary engineering. The reasons for each test are discussed, followed by the chemical principles of the test method. This writing is not intended to replace "Standard Methods," but is certainly a valuable adjunct to that text, especially to one who is not a trained chemist.

In this reviewer's opinion, Sawyer's book is not only a good college text but is also suitable for a program of individual study. It should be on the desk of every practicing sanitary engineer. This is the first in McGraw-Hill's series in Sanitary Engineering and Science, and is an excellent beginning. V.W.L.

Application of Fluorides to Water*

by WILLIAM T. INGRAM
Adjunct Prof.,
New York University,
College of Engr.
New York, New York

■ AMONG THE QUESTIONS often raised with respect to water fluoridation is the one concerning the cost of installation, maintenance and operation of fluoridation units. The author has made extensive studies of fluoridation practices in twenty major cities of the United States[1] and has accumulated additional data that may be helpful to engineers, water plant superintendents, and others who may find it necessary to make estimates of water fluoridation costs and to plan for the application of fluorides to water.

Treatment Practices

Application systems for fluoride bearing chemicals vary in detail according to the layout of treatment units and water plant design. In some plants it was necessary to build additional space to add application equipment or to provide storage for chemical. In others it was only necessary to make minor alterations to provide all required space. Cities such as Denver, Colo., Indianapolis, Ind., Milwaukee, Wis., Pittsburgh, Pa., Providence, R.I., and San Jaun, Puerto Rico, have used sodium silicofluoride successfully. Others such as Charlotte, N. C., and Norfolk, Va., have used sodium fluoride. St. Paul, Minn., has used both and in 1957 changed to hydrofluosilicic acid.

Dry Chemical Application Systems

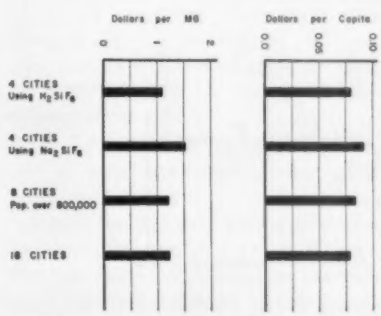
The essential components of application systems for dry chemicals such as sodium silicofluoride (Na_2SiF_6 include:

1. Means of delivery by truck or rail.
2. Dry storage space.
3. Provision for moving chemical from storage to charging hopper.
4. Hoppers for feed supply.
5. Measuring and proportioning equipment equipped with chemical feed regulation, overload protection and alarms.
6. Recording charts to record time of operation, weight and other operating data.
7. Regulation of water flow to solution tank.
8. Mixing and solution tank.
9. Transfer line for chemical solution to point of discharge.
10. Discharge pipe placed to obtain good mixing of chemical solution with water flow.

Large plants may find it convenient and more economical to have dry chemical delivered in either bulk or in bags or drums. The material is then transferred to storage bins by a pneumatic transfer system under negative pressure to avoid dust. It is essential that no dust be allowed in the general atmosphere of the treatment plant. Normally, bags are placed on pallets which can be transferred by fork lift truck to storage. In smaller plants, the transfer may be accomplished by hand on transfer dolleys. Larger plants keep from 40 to 125 tons of material available in storage while the small plants can be well supplied with 10 to 15 tons storage. While actual storage need is dependent on the relative ease of replacement and proximity of the source of the chemical, it is desirable to have approximately three months supply within easy reach of the plant.

Each feeder unit must have a storage hopper which can feed chemical to it by gravity. Although the chemical storage facilities used for other chemicals have been converted to fluoride chemical storage, the feed storage need not be larger than one day's supply. The hoppers are usually filled once each day.

The top of the hopper is of closed construction with a self-closing charging door. A local exhaust ventilating system equipped with dust removal equipment is connected to the top of the hopper so there is no excessive dust discharge either around the hopper or to the outside atmosphere. Workmen wear gloves and dust respirator masks while transferring chemical from bags or drums to the charging hopper.



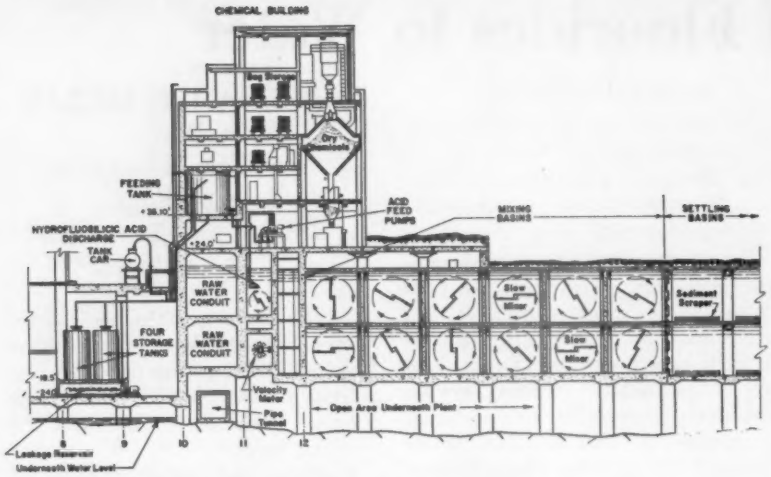
NEW YORK UNIVERSITY water fluoridation study.

Weighing and measuring units are of two types. Both are available from commercial manufacturers. The weighing type is constructed in such a way that material is fed to a belt which either vibrates or moves the material fed to it onto the solution tank. With the material weighed as it feeds, the actual quantity fed over a given period of time can be accurately checked. Dosage or feed rate can be set by a scale calibrated to the chemical in use. A change in balance activates adjusting devices regulating the amount of material fed, thus avoiding both over and under dosage. Alarms signal defective operations, and some machines are equipped with cutout relays which stop the flow of chemical entirely if the feed chute is flooding.

The volumetric type is suitable for small installations. A hopper supplies material to a feeding orifice which can be adjusted to the desired dosage rate. The unit is mounted on a scale permitting any loss in weight to be recorded.

Both sodium fluoride (NaF) and sodium silicofluoride (Na_2SiF_6) must be put into solution. Hence, the mixing and solution tank is equipped with a water flow such that the desired F ion content will be obtained. Sodium fluoride has a solubility of 4 per cent at 60° F while sodium silicofluoride solubility is approximately 0.4 per cent at 75° F. Furthermore, 19.3 lbs of NaF in 58 gallons of water, when applied to one million gallons of water, will produce a content of 1 mg/l and 14 lb of Na_2SiF_6 in 335 gallons of water will produce the same dosage when applied in one million gallons of water. Care must be taken to prevent the precipitation of calcium fluoride (CaF) as a

*Prepared in September 1960 for publication in "Water and Sewage Works".



SECTIONAL ELEVATION of hydrofluosilicic acid system.

crustation, in the solution tank and pipe lines leading to the point of application. Weaker solutions do not precipitate CaF, hence it is suggested that units be designed and operated using three to four times the required amount of water for saturation. At least 9.3 gallons per pound of NaF and 76 gallons or more per pound of Na_2SiF_6 should be used. This quantity may be cut back on an experimental basis to determine a lesser volume that could be used without precipitation of CaF in any specific water.

Plastic pipe offers the least trouble in carrying fluoride solution to the point of application. Many plants have used polyvinyl chloride pipes successfully. Restrictions at the discharge point are to be avoided. It has been the experience at many plants that nozzles and diffusers could be removed without causing any difficulty in obtaining complete mixing and a satisfactory level of F ion in the water.

Liquid Chemical Application Systems

The most widely used liquid application of fluoride bearing chemical is one using hydrofluosilicic acid (H_2SiF_6). Large cities such as Chicago, Philadelphia, Baltimore and St. Louis have used acid successfully.

Components of the system for liquid application are not greatly different than those for dry chemical application. Tanks are provided for storage. Concentrated acid, 24 per cent F or greater, is placed under air pressure or drained by gravity from tank cars or tank trucks into storage tanks at treatment plants. The size of storage tanks is, as in dry chemical storage, dependent on the availability and shipping distance of supply. Baltimore, with its source within trucking distance, provides less than 12,000 gallons total storage for its two plants. Chicago has nearly 740,000 gallons storage capacity distributed among three plants.

Small supply tanks are used ahead of some form of positive action pump. Pumps are built with plastic heads with diaphragm or piston action, and no acid can bypass the pump. Hence, when the pump is not working there is no feed. Pumps can be regulated to feed the required amount of acid. At 23.75 per cent acid concentration, 3.34 gallons applied per million gallons of water will produce a concentration of 1 mg/l F ion. Chemical feed pumps of the positive feed type are available from a number of manufacturers.

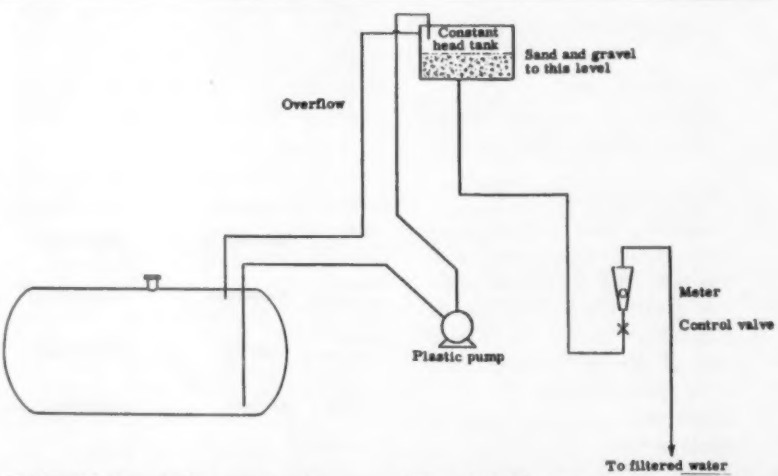
Records of the amount of chemical fed can be kept accurately by gauge readings on tanks. Pumps can be calibrated accurately. Meters are also used following a constant head tank. A continuous flow of acid is pumped to the tank with an overflow return. A variant on this is to remove a known volume from the head tank by dipping at predetermined speed. In such installations, the acid is diluted to a lesser concentration (18 per cent F^- at Chicago).

Dry Feed

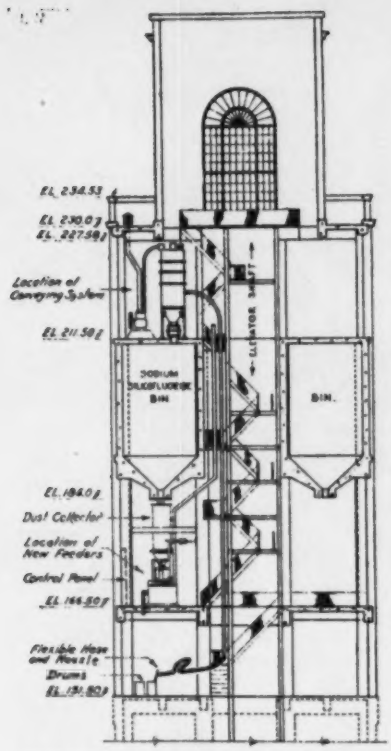
Omega GLW-O	W & T 378041
Omega GLW-ORL	W & T XA107041
Omega Volumetric Model 50A	W & T A417
Omega 51F	Infilco Volumetric Converted Soda Ash Feeder
W & T Merchen Type WB9LMG	Converted Activated Carbon Feeder
W & T A635	

Liquid Feed

Proportioneers Model 2-47
Vanton Type XB
Milton-Roy Displacement
Hills McCanna Model UM-2F
Omega Rotodip Model 65



FLUOSILICIC ACID application — City of Baltimore, Bureau of Water Supply, Purification Division.



FLUORIDE INSTALLATION, tower section, Washington, D. C. water system.

Feeder Equipment

During the studies previously mentioned, the author obtained information on feeder equipment used for fluoride chemical application in thirty water systems. The following provides information on different types of equipment in use at the time of the studies.

Chemical is required to meet Standards of the American Water Works Association[2, 3, 4]. Money is saved by letting annual or longer contracts. The appropriate specification is normally incorporated in the contract specifications.

Operating Problems

Problems of handling fluorides are not materially different than those of handling other water treatment chemicals. The usual precautions need to be taken to keep equipment in order and properly maintained. Protection against dust is probably less of a problem since the material quantities handled are not as great. Local exhaust ventilation combined with care in emptying sacks or drums into charging hoppers, plus good housekeeping, provides adequate dust control.

Operators have experienced the following and have taken care of the situations arising without unusual difficulty.

1. Clogging, arching and blocking of the dry chemical in storage hoppers occurs if the salt is too fine and powdery.
2. Over-running to the feeder mechanism will occur when the material is too free flowing.
3. Dampness in the chemical causes balling and the material may arch and block the chute.
4. Solutions that are too near saturation will cause encrustation in the chemical feed pipe and cause deposition of precipitated materials at the openings of diffusion or dispersion tubes.

When a source of supply is changed, it is desirable to make careful observation of its handling behavior and to make minor adjustments to control flow.

Daily laboratory control checks, weight checks, and other usual plant control procedures apply to the process of fluoridation as they do to the handling of other chemicals.

From the above discussion of treatment practice, it can be observed that the installation of water fluoridation treatment is usually quite feasible and not inconsistent with the installation of other types of treatment. The only type system that presents special problems is one having many individual and isolated wells or surface sources as a source of supply. Each source leading directly to the distribution system must have a feeder unit. San Juan, Puerto Rico, has 59 fluoridation stations, each equipped with chemical feeding apparatus. Philadelphia has five stations with seven feeding units. Chicago has three stations with six feeding units.

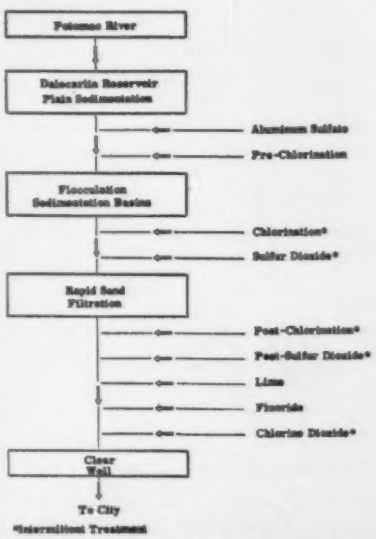
It has not been found necessary to install duplicate equipment. Decreased fluoride content in the system for short periods of time, such as that required for repair, is not critical.

Maier[5] has described a method for use at water treatment plants using alum for flocculation. Advantage is taken of the fact that fluorspar, (least expensive of the sources of F ion), can be dissolved in solution containing aluminum sulphate in direct proportion to the strength of the alum. A 10 per cent solution of alum will produce 1 per cent fluoride. It requires approximately two hours at room temperature to dissolve the fluorspar. An excess of fluorspar must be present, and stirring must be vigorous and continued during the dissolving period. At small plants, the fluorspar may be dissolved in a separate small unit which combines the alum and fluorspar. In larger plants equipped with suitable measurement controls, the chemicals could be added to the mixing channel. Calcium fluoride sludge forms and must be removed. A fluorspar treatment unit having 8.0 mgd capacity in operation at the water utility serving Rosiclare and Elizabethtown, Illinois, has been described by Maier. On the basis of that operation, Maier believes that this type of unit can be scaled upwards to treat water flows of large city water systems.

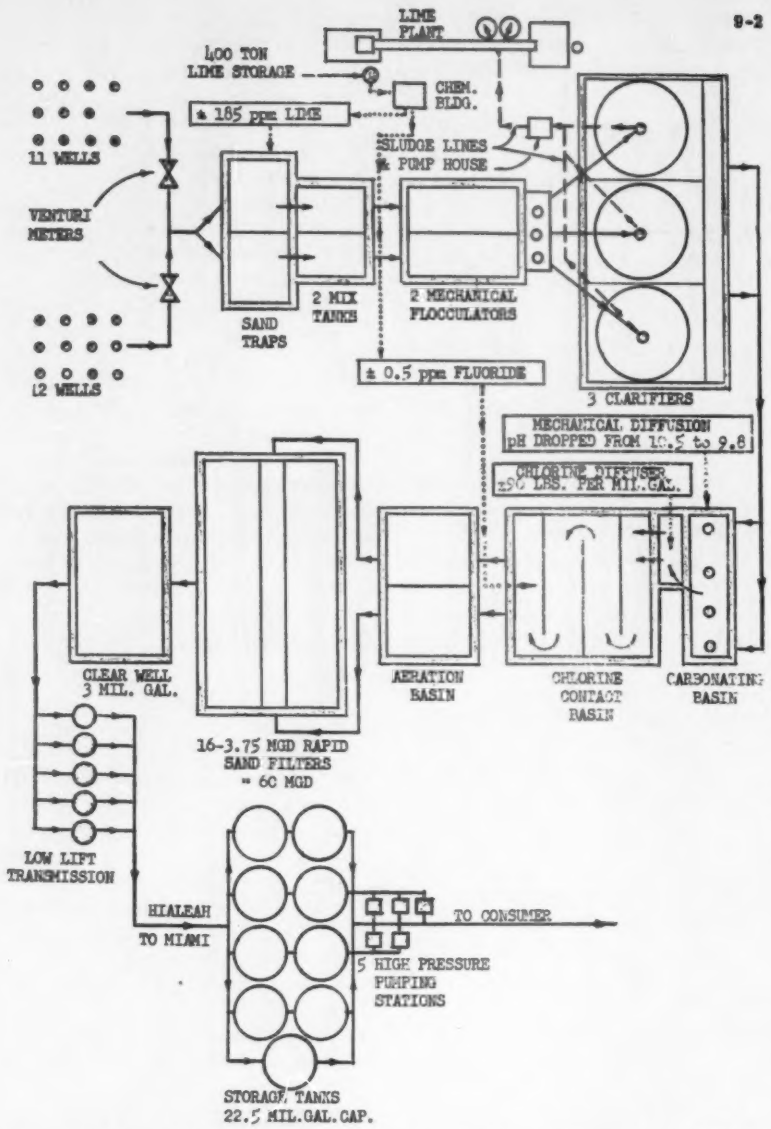
Costs of Fluoridation

The costs of fluoridation can be divided essentially into: 1. the costs of construction, including purchase and installation of equipment; 2. the costs of fluoride bearing chemical; 3. the costs of operation, maintenance and control of the application of fluoride to water.

The studies previously referred to included cost data on 18 major cities in the United States. These data include the costs of treatment over a wide range of water quality characteristics, use of three chemical sources of fluoride, a variety of application methods, and wide variation



WATER TREATMENT diagram, Dalecarlia Filter Plant, Washington, D.C.



FLOW DIAGRAM of Hialeah water treatment plant. Department of Water and Sewers, City of Miami.

of distribution system conditions. Fluoride content of some source waters is little while in others there is nearly enough to satisfy the recommended optimum of 1 mg/l F^-.

The 18 cities provide a flow of 3,147 mgd to a population of 17,801,000. Five of the systems served over 1,000,000 population each and accounted for 34 per cent of the total population being served fluoridated water in 1956.

Construction Costs

Actual construction costs are necessarily related to the time of construction. All of the plants studied have been installed since 1949 when Charlotte, N.C., made its installation. Two, those at Louisville and Indianapolis, began operation in 1951. Eight, including Baltimore, Washington, San Francisco, Pittsburgh, Miami, Providence, Norfolk, and St. Paul, were completed in 1952. Milwaukee in 1953, Denver and Philadelphia in 1954, St. Louis and Toledo in 1955, and Cleveland and Chicago in 1956 followed.

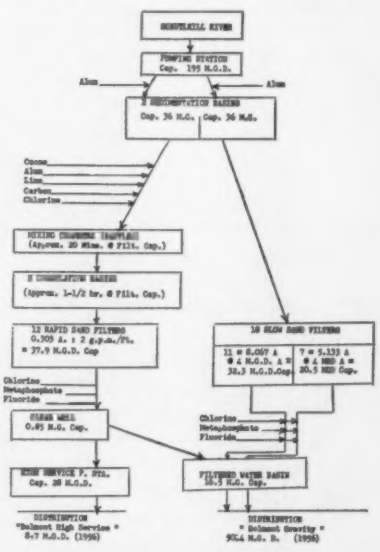
Construction costs are affected by the availability of existing equipment. For example, Indianapolis added no new equipment and Louisville altered its existing equipment. At the Ashburton plant in Baltimore, fluoridation equipment was part of the original construction and was not considered an additional cost. Charlotte was able to use the structure of the existing plant so the construction cost included only the equipment and cost of installation.

Source fluoride content also affects the amount of construction and the sizing of equipment. St. Louis sources average 0.40 mg/l F^- at its Chain of Rocks Plant and 0.49 mg/l at its Howard Bend Plant. On the other hand, source waters at San Francisco, Norfolk and Toledo contain little or no fluorides. More than half of the water used in Denver had a sufficient amount of fluoride from natural sources.

Total costs of construction are, therefore, found to be over a wide range from $0 to $382,040. The average cost of construction per million gallons of water to be treated was $0.763. Construction costs should be amortized in order to estimate an annual charge. Amortization practice is variable. Many cities used either a straight line depreciation over a 10 or 15 year period or calculated the amortization value on a 15 year base at 3 per cent interest. Annual costs of construction ranged from $0 to $32,000, the average of 18 cities being $3,695 or 5.8 cents per million gallons.

Chemical Costs

The cost of chemical is a function of the amount used and unit price. The cheapest of the chemicals is fluorspar. Among the three chemi-



FLOW SHEET for Belmont filter plant, Philadelphia.

Table 1
Water Fluoridation Study
Unit Costs—Water Fluoridation

	4 Cities* Using H_2SiF_6			4 Cities** Using Na_2SiF_6			8 Cities Pop. over 800,000			18 Cities		
	$	¢ cap.	$/MG	$	¢ cap.	$/MG	$	¢ cap.	$/MG	$	¢ cap.	$/MG
Construction Cost												
Total	504,086	5.7	.78	276,709	6.3	1.03	780,795	5.9	.86	876,048	4.9	.76
Annual	40,839	.5	.06	18,093	.4	.07	58,932	.4	.06	66,515	.4	.06
Annual Oper. Cost												
Chemical	577,954	6.5	.90	355,316	8.1	1.32	933,270	7.0	1.02	1,192,892	6.7	1.04
Total	669,824	7.6	1.04	388,084	8.8	1.44	1,057,908	8.0	1.16	1,340,269	7.5	1.17
Annual Cost	710,663	8.0	1.10	406,177	9.2	1.51	1,116,840	8.4	1.22	1,406,784	7.9	1.23

* Chicago, Philadelphia, Baltimore, St. Louis.
** Cleveland, San Francisco, Washington, Milwaukee.

cals used in the 1957 study, sodium silicofluoride was purchased at about $155 per ton, sodium fluoride ran about $280 per ton, and acid was available at $50 to $62 per ton, (24% F^-). The actual amount spent in 1956 for chemical ranged from $15,891 at Providence to $288,000 at Chicago. The average chemical cost amounted to $1.04 per million gallons.

Operations and Maintenance

At treatment plants where other chemicals are used it is difficult if not impossible to determine the specific time an operator spends on fluoride equipment operation as opposed to alum or lime equipment operation. Many treatment plant cost accounts provide only for such items as specific repair as added costs due to fluoridation. When fluoride application plants are situated so that an addition to its staff is needed for operations, laboratory control, and/or other items related solely to fluoride application, a charge is made. In the 1957 study annual operations and maintenance charges ranged from $0 to $81,585. Total operations, including cost of chemical, averaged $1.167 per million gallons treated.

Total Costs of Fluoridation

The average 1956 cost of water fluoridation in 18 major cities was $1.225 per million gallons or 7.9 cents per capita. San Francisco and Providence were median cities with an annual cost of $1.32 and $1.16 respectively. Denver, at $.30 per million gallons, was low and Charlotte, at $2.87 per million gallons, was high.

The investigation included an analysis of four cities using sodium silicofluoride and four cities using acid as a source of F ion. Table 1 provides a comparison of unit costs and shows average construction costs, annual operation costs, and annual cost. The difference in unit costs between systems using acid and systems using sodium silicofluoride is striking. Acid application was $1.10 per million gallons compared with $1.51 per million gallons for sodium silicofluoride. Among the eight cities, the range of costs was $0.71 to $1.85 per million gallons treated.

Another study, made in California[6], contains cost data on nine cities in the San Francisco Bay Area. Exclusive of San Francisco, eight community systems serve fluoridated water to 212,100. The range of initial equipment costs in those eight cities, ranging in population from 2,200 to 80,000, was $0.22-$1.37 per capita. The average initial equipment cost was 56.5 cents per capita. By comparison the 18 city average was 4.9 cents per capita. It is clear that the initial equipment per capita cost is markedly less in larger cities.

Summary

As a summary statement, it may be said that there are no unusual conditions occurring which require peculiar designs for the application of fluorides. The practices which exist in application of chemicals such as alum, lime, activated charcoal, and other chemicals can be adapted to the specific design of fluoride chemical application units. Cost of structures and equipment, selection of equipment and chemical based on ability to perform and cost and availability, provision for accurate dosage control, the normal safeguards for handling dusty chemicals or strong acids, and provision for good laboratory supervision are the essentials to be planned and provided for.

There appear to be economic advantages in lesser costs for construction and feeder equipment in acid plant installations. Depending on a number of variables, a specific installation should not cost more than $2.50 per million gallons annually to construct and operate, and in larger cities the cost should not be over $1.85 per million gallons.

Serviceable and dependable equipment for measuring and feeding fluorides is available from manufacturers. It is a matter of selecting the appropriate units for the needs of a specific installation.

Acknowledgment

This paper has been prepared in part from data obtained by the author in a study of water fluoridation practices in the United States conducted by the Research Division of New York University, College of Engineering, for the New York State Department of Health. The use of this material is gratefully acknowledged.

References

1 Ingram, W. T. and Moore, G. W., "Fluoridation in Major Cities of the United States", *Jour. AWWA, 51,* 9, 1095 (Sept. 1959).

2 AWWA Standard for Sodium Silicofluoride—AWWA B702-55. Am. Wtr. Wks. Assn., New York (1955).

3 AWWA Standard for Fluosilicic Acid —AWWA B703-55. Am. Wtr. Wks. Assn., New York (1955).

4 AWWA Standard for Sodium Fluoride —AWWA B701-54. Am. Wtr. Wks. Assn., New York (1954).

5 Maier, F. J., "Advances in the Use of Fluorspar for Fluoridation", *Jour. AWWA, 52,* 1, 97 (Jan. 1960).

6 ....., "Fluoridation Equipment Information for Nine Cities in the Bay Area District". Report, Bureau of Sanitary Engineering, California State Department of Public Health (Mar. 1957).

Synthetic Detergents in Ground Waters — *Part 1*

by LOUIS G. CAMPENNI, P.E.
FHA Zone Engineer
Bayside, L.I., New York

■ THE RISING use of synthetic detergents in this country during the past decade has introduced new problems in the water supply and sewage disposal fields. It is known, through the evidence of findings and the increasing publicity being given to the subject by Federal agencies, health authorities, research organizations, well-driller's associations and industry, that synthetic detergents (syndets) are not only capable of but are causing deleterious effects upon individual wellwater systems, public water systems, surface and ground water qualities, and sewage treatment plant operations. This discussion will deal with one phase of the problem: the effect upon individual well-water systems. The subject matter presented herein* does not necessarily reflect the official viewpoint of the Federal Housing Administration.

Discussion of Syndets

A knowledge of the nature and characteristics of syndets should prove helpful, before proceeding further on the subject. The use of syndets in this country has increased by about 700 per cent during the past decade. It is estimated that, at present, syndets represent about 72 per cent of the total market for cleansing agents of all types. Even a greater percentage can be anticipated with the application of syndets to bar soaps.

A syndet can be broadly classified as a chemical agent with cleansing qualities. Although soaps also fall into this general classification, there are important basic differences between the two. The syndet contains six major properties: solubility in water, wetting action, emulsifying action, stability in the presence of hardness, dispersing properties, and high resistance to biochemical degradation or breakdown. The syndet is about 25 per cent organic, while the soap is about 60 to 80 per cent organic. The soap is relatively unstable in the presence of hardness and acids, and has low resistance to biochemical degradation. Differences such as these have played a great part in the development and stimulation of syndets as a substitute for soaps.

The syndet is basically made up of two major constituents, known as surface-acting agents or surfactants and builder's agents. The builder's agents comprise about 67 per cent of the total. The surfactant is the active agent and combines the syndet properties mentioned before. The three types of surfactants are known as anionic, cationic and non-ionic, depending upon the degree of ionization developed and the nature of the electrical charge upon immersion into water. The anionic type is the most common by far, and represents about 72 per cent of the total. Because of its predominance in the field, the laboratory testing procedure for syndets consist in testing for anionic surfactants. The term "ABS", which one frequently hears, refers to the alkyl benzene-sulfonate group of the anionic surfactants. The cationic surfactant bears a positive charge as contrasted to the anionic type which bears a negative charge. The cationic surfactants has germicidal properties, is chiefly used as a sanitizing agent and is the most toxic of the three. However, the cationic type is rarely encountered in water, since it is neutralized by the more prevalent, oppositely charged anionic. The third type of surfactant is the non-ionic, which does not ionize appreciably in water and is usually non-sudsing. The non-ionic is on the rise in the market, and is most commonly used after the anionic type.

*Based on a talk presented before the 1960 Home Sewage and Waste Disposal Conference, Michigan State University, East Lansing, Michigan.

The builder's agents comprise about 67 per cent of syndets and are inserted to further improve the basic detergent properties. They consist of chemical compounds such as phosphates, silicates, etc. Since the advent of syndets on the market, it is stated that the phosphorous content of domestic sewage has at least doubled.

Analytically, the laboratory test for syndets consists of reacting the anionic surfactant with methylene blue dye, the latter being a colored cation, with formation of a blue salt. Chloroform is then used to extract only that portion of the methylene blue which has combined with the anionic surfactant, which is the blue salt, and the intensity of color produced is measured photometrically or by means of a commercially available syndet color comparator. The photometric determination uses a calibrated anionic surfactant chart for comparison purposes. Since the concentration of the anionic surfactant varies directly with the color produced in this determination, as the syndet concentration increases the color increases.

The Suffolk County, L. I., Problem

Description of Long Island

Long Island, N. Y., includes the four counties of Kings, Queens, Nassau and Suffolk. Kings and Queens are part of the city of New York, have a little over four million people between them, and are practically fully served by public water and sewerage facilities. Nassau County, lying to the east of the Queens border, has a population of about 1.5 million and is almost fully developed. Nassau County is virtually fully

served by public or publicly controlled centralized water systems, with only a small percentage of public sewerage facilities. However, a master sewerage system was started a few years ago. The extreme western part is now sewered and progress is continuing on this plan. Because of the extremely porous subsoil in Nassau County, the vast numbers of individual sewage disposal systems in use are giving good service, but they have caused some pollution of the relatively few individual well-water systems still in use. Little data is available as to the possible pollution by syndets of the public water systems all of which use central wells.

Suffolk County is the most easterly of the four counties but covers about two-thirds of the Island in area. Although the population of Suffolk County is the lowest of the four counties (0.7 million), it is the most rapidly developing, and has a high population potential. Suffolk County is less than 5 per cent publicly sewered, with most of these serving business areas. The dual cesspool type of individual sewage disposal system is commonly used, and service has been good because of the highly permeable subsoil. Unfortunately, however, the high permeability of the subsoil has contributed in part to syndet and sewage pollution of the individual wells.

About one-third of the population of Suffolk County is served by individual well-water systems, which are normally driven into the highly permeable sand and gravel strata underlying most of the County. It is estimated there are about 50,000 such wells. There are about 90 public or privately owned centralized water systems, but these facilities are so scattered and varied in size as to leave many areas without service. The rapid development of the county has furthermore placed these central water systems out of reach in many areas.

Geology of Suffolk County

The County contains three water-bearing strata which for all practical purposes can be considered as separate hydrologic units. The Glacial Stratum underlies most of the Island and is the closest to the surface. It is composed mostly of highly permeable sand and gravel deposits interspersed occasionally with small clay layers. The Glacial Stratum is a highly productive water-bearing formation, its water table is relatively close to the surface, and it is therefore almost exclusively tapped as a source of water supply. Unfortunately, the use of this upper stratum as a source of disposal of sewage effluent from the commonly used individual sewage disposal systems, makes the continued use of this stratum questionable since it is becoming increasingly polluted.

The Magothy Stratum underlies the Glacial Stratum, and is much less permeable, being chiefly composed of fine clayey sands and silts. Because of its depth, wells of over 100 feet would be necessary, but it probably contains a reasonably good, though limited, source of water. It is virtually untapped. The third, and deepest stratum, is the Lloyds Sand, composed chiefly of sands, gravels and some clays. It is artesian in nature, being separated from the overlying Magothy Stratum by an impermeable stratum called Raritan Clay.

Discovery of the Syndet Problem

During 1955, the County Health Department was investigating individual well-water complaints from a small community in the southwestern part of the county. The residents complained about unusual tastes, odors and color in the well-water supplies. It was finally revealed by the Health Department that the source of the complaints was from hexavalent chromium waste discharged from a metals finishing plant located near the community.

Wastes were being discharged into large underground disposal pits, with the seepage from the pits entering and polluting the ground water as it flowed towards the community. Laboratory analyses revealed that the well-water samples carried as much as 10.8 ppm of hexavalent chromium. The U. S. Public Health Service Standards recommend a maximum safe concentration of only 0.05 ppm. It was also found that the chemical waste had traveled over 1,000 feet from the source, was still affecting wells two years after the plant was shut down, and was highly objectionable to the consumers of the affected well-waters. Residents purchased bottled water for as high as $0.17 per quart.

While the investigation was being made of the hexavalent chromium waste, it was further discovered that there were also syndets in the well-water supplies. The physical characteristics of the community included 300 houses on typically sized 60′ x 100′ lots, driven wells varying in depth from 14′ to 56′, water table at about 7′ to 12′, and a porous, deep layer of sand and gravel subsoil. The origin of the syndets was from the individual sewage disposal systems. A chemical breakdown of typical polluted waters revealed that abnormal concentrations of chemicals normally associated with sewage, such as nitrates and chlorides, plus high oxygen consumed tests, were found. The syndet, found in one-third of the wells tested, ranged from a trace to 1.4 ppm. There were complaints of foaming, tastes and odors in various degrees.

Action Taken by the FHA in 1957-1958

Cooperation between the Suffolk County Health Department and the Federal Housing Administration sanitary engineer serving the local FHA field office in Jamaica, New York, has been close and constant, in a common effort to find ways and means to control and solve the problem. It is emphasized that the FHA field office's policies and procedures regarding the matter have been under the continuous guidance and consultation of its sanitary engineer.

The FHA field office immediately set up a policy to refuse all applications in the syndet-polluted area for mortgage-insurance purposes. This policy became effective in late 1957. The FHA sanitary engineer realized that the problem was probably more widespread than the immediate health department survey indicated. Because of a similarity in subsoil and ground water conditions, plus other physical factors involved, the sanitary engineer advised the FHA field office to cease accepting lots in similar surrounding areas with individual wells and sewage disposal systems. Furthermore, the FHA field office suspended accepting subdivisions in the county where both individual wells and sewage disposal systems on the same lot were proposed. It awaited further information on the problem.

The Federal Housing Administra-

tion objectives for an acceptable water supply include requirements for a potable, palatable, and continuing supply. Although it was not proven the syndet pollution was unsafe, it was proven to cause adverse effects upon the palatability of the water supplies, and because of its sewage origin could be suspected as indicating a possibly unsafe water.

In August, 1958, the FHA field office issued a public circular which set forth new requirements for acceptability of lots containing both individual well-water supplies and sewage disposal systems, and these requirements were limited only to non-subdivision lots where public water was deemed infeasible. They included:

1. Wells must be driven at least 40 ft below the ground water table, with the minimum overall acceptable depth being 50 ft.
2. A minimum depth of 20 ft of watertight casing must be provided.
3. Minimum separating distance between wells and disposal systems must be 100 ft for all types of sewage disposal systems.
4. All constructed wells must be certified to by a licensed well-driller as to compliance with these new requirements and all other pertinent FHA outstanding requirements.

At about the same time the FHA issued these new requirements for individual wells and sewage disposal systems on the same lot, the Suffolk County Health Department issued a Resolution to the ten towns of the County setting forth new County Health Department requirements on the same subject. The County Health Department's new requirements:

1. Concurred with the new FHA minimum well depths.
2. Increased the minimum separating distance between well and sewage disposal system from 65′ to 100′, with one concession. Where the new 100′ distance was impossible to attain, it permitted reduction of the distance to no less than 65′, provided that the well was driven to a greater depth than the new minimum of 40 ft below the water table, in a manner proportionate to the amount of decreased permissible horizontal separating distance.
3. Towns were required to submit substantial evidence that constructive means were being taken to make public water more accessible.
4. A ¾″ copper service line was to be installed at the time of the individual well installation, for future public water connection.
5. Subdivisions with both individual wells and individual sewage disposal systems would be considered only after it has been determined that feasibility of public water is not evident, that the new minimum well depth and separating distances to the sewage disposal systems are complied with, and that the maximum plot density does not exceed two houses per acre.

New Policy Established by FHA in 1959

Further studies of the syndet problem by the County Health Department, with continued cooperation and consultation by the FHA Sanitary Engineer, confirmed that the problem was definitely widespread and not confined to the high-density, high-water table areas in the southwestern part of the county. Evidences of syndet pollution were picked up in areas further to the east, in areas with plot sizes up to ½ acre, and water tables up to 40 ft. This was not surprising, since previous studies had revealed the stability of the syndets, their ability to travel long distances both vertically and horizontally, and the typical subsoil conditions found in these syndet-polluted areas.

After a series of conferences with the Health Department, builders and well-drillers, the FHA field office issued a new set of requirements pertaining to acceptability of lots with both individual wells and individual sewage disposal systems. The purpose of these new requirements were to (1) provide a greater measure of safety to the wells regarding potability and palatability features, (2) curtail or preclude FHA participation in slowly developing areas being built up by numerous small builders, with the end result involving high-density subdivision-type situations, (3) preclude any FHA participation in areas that have a history of or have a potential for syndet-polluted, and possibly bacterial contaminated, drinking water supplies.

The new FHA requirements were issued by a public circular in April, 1959, and the following basic stipulations were specified:

1. Pertained only to individual, scattered lots. No subdivisions or developing areas with lots containing both individual wells and sewage disposal systems were considered for mortgage insurance purposes.
2. Individual wells would not be considered in any areas where the depth of the water table in the upper Glacial Stratum was less than 40 ft below ground surface.
3. The well must now be driven at least 40 ft below the minimum permissible water table depth of 40 ft. This would therefore require a minimum overall well depth of 80 ft.
4. Minimum allowable lot size would be 20,000 square ft. This was to allow the home owner to relocate his well or sewage disposal system if necessary, without endangering his neighbor's well supply, or his own. Furthermore, if slow, piecemeal development of some areas with individual sewage systems occurred, and this was not preventable in all cases, then the areas in which the FHA could be involved would be restricted only to low-density, deep-well areas. Also, the larger lot size would give the builder some means to locate the well system reasonably away from the path of sewage discharge from on lot, or from adjacent individual sewage disposal systems.
5. All wells showing evidence of syndets would be rejected. This affected particularly existing lots with well-water systems.
6. Minimum separating distances between well and sewage disposal system were maintained. Well-driller's certification of "as-constructed-well" was maintained as a requirement, as were casing details.
7. All highly built-up areas, where individual wells and individual sewage systems were involved on an existing or proposed construction basis were ruled out for further consideration
8. Before wells and individual sewage systems on the same lot

would be considered, the applicant was required to furnish an economic feasibility report concerning location of nearest public water main and possibility of connection, as compared to cost of the individual well system.

Investigation of Problem by the Builders

In June, 1959, the Long Island Home Builder's Institute contracted the services of the largest well drilling organization on the Island to further study the problem. In a rather limited study, but one receiving the cooperation of the FHA sanitary engineer and Health Department, it was found that a very light evidence of syndet-pollution was encountered in subdivision areas up to ½-acre plot sizes, in subdivisions less than 3 years old, and water table areas up to 44 ft depth. It indicated that although there is evidence of syndets finding their way into light-density areas with deep water table, these factors of light plot density and deep water table cut down on the problem and probably are factors of relative safety. However, these factors only appear to be time-saving devices, and are not a solution to the syndet pollution of the ground waters.

Summary of Imposed FHA Requirements

The established FHA field office standards with relation to acceptability of individual well-water and sewage disposal systems on the same lot are stricter than those presently in force by the Suffolk County Health Department. Since late 1957, the FHA field office has not accepted subdivisions with such facilities. It ceased insuring proposed and existing houses in highly built-up areas in early 1959. It has set up new minimum well-depth criteria based upon factual data received to date which indicates that wells of lesser depth, and in shallower water table areas have or probably will become syndet-polluted. Minimum lot sizes have been established as another criterion for acceptance based upon the plot-density being a factor for impossible well pollution.

The County Health Department, which has greatly strengthened its requirements regarding individual well systems and sewage disposal systems on the same lot imposes lesser restrictions than the FHA office at this time apparently based on the probability that it is close at hand and may increase its restrictions if rapid deterioration of ground water occurs. The Federal Housing Administration, on the other hand, considers a water supply on the basis of palatability in addition to other adversities. It is known that syndets cause taste, odor and aesthetic problems when reaching certain concentrations, said to be in the range 1.0-1.5 ppm. Considering the long-term aspects of FHA requirements governing acceptability of properties for mortgage-insurance purposes, the affect of palatability upon water supplies which the syndets are known to cause, the origin of syndets from sewage disposal, and the tendency for syndets to build up in a ground water over a period of time, this author believes that the FHA field office requirements are justified and realistic.

FHA and Health Department Control Measures

It is encouraging to note that since the imposition of the FHA and Health Department control measures, progress is being made to solve County ground water supply problems. The Suffolk County Water Authority, which is a Public Benefit Corporation and largest supplier of water in the County, has liberalized its public water expansion policies. The Suffolk County Water Authority has increased the allowance per customer for free water main extension, from 50 to 70 ft. This represents about a $100 savings per home owner. The Authority has adopted a surcharge plan designed to permit customers to repay the cost of water extension over a long period of time. The Suffolk County Water Authority and the Suffolk County Board of Supervisors are examining the feasibility of legislative and financial adjustments aimed at liberalizing present water main expansion policies.

New legislation was passed in March, 1959, to modify existing town laws to more readily permit formation of water districts. Water committees and civic associations have been formed to explore the water supply problem and to find ways to more easily provide public water. There has been talk about planning a master sewerage plan for the County. There has been more interest expressed by builders to provide central water supply systems, and some have submitted plans. There has been a radio address to the County residents by its Congressional Representative, advising them of the water supply problem with relation to syndets, and the need for a fresh constructive approach to the problem.

The 108th Operating Report of The Department of Water Supply, City of Detroit.

Net water pumped to the Detroit Water System was 176.663 billion gallons, an increase over last year of 1.53 per cent, according to the 108th Operating Report of Detroit Water Supply Department. The Report is for the fiscal year ending June 30, 1960.

The system delivered an all time peak-hour pumpage of 52,220,000 gallons at 6 to 7 p.m. on July 15, 1959, as well as an all time record daily pumpage of 864,400,000 gallons on July 16, 1959.

Revenue from water sales increased $2,906,075.60 over the previous fiscal year. Aproximately $2,100,000 of the increase was due to a general rate adjustment made effective on all bills rendered on and after November 1, 1959.

Other increases in water sales were roughly $250,000 due to increased consumption in all customer classifications, $450,000 for furnishing peak hour service to suburban communities and $100,000 for scheduled increases in the air conditioning demand charge.

The cost of operation and maintenance, exclusive of the annual depreciation charge, increased $229,491.76.

In the Sewage Treatment and Disposal System Operation, the total pumpage of 226.717 billion gallons was an increase of 14.546 billion or 7 per cent over the previous year and was the greatest yearly total. The average daily flow was 619.4 billion gallons, an increase of 38.1 million gallons a day.

Algae Meet their Match as . . .

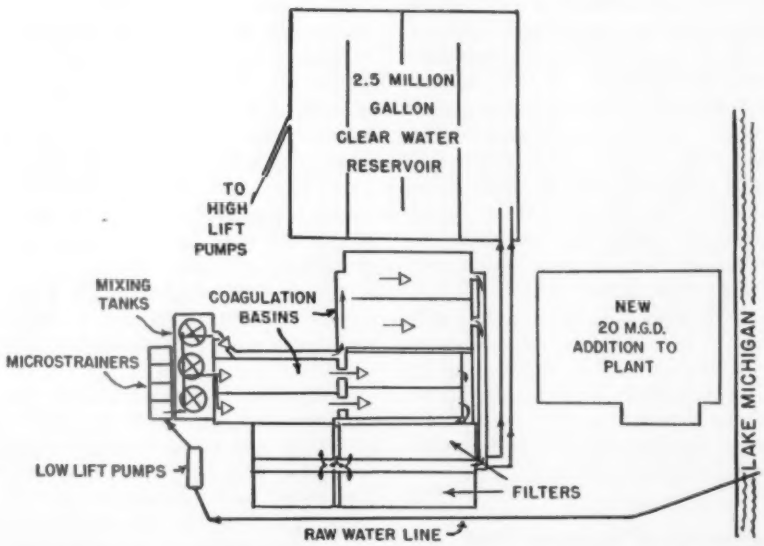
Microstraining Helps Kenosha

by O. FRED NELSON, Manager
Water Department
Kenosha, Wisconsin

■ FIFTY MILES NORTH of Chicago and thirty-seven miles south of Milwaukee lies Kenosha, home of American Motors. Presence of the automotive firm has contributed to community growth which in turn has placed great demands on the water system, particularly on the filtration plant.

Demand Exceeds Capacity

Rated 20 mgd, the treatment plant has provided disinfection and alum coagulation, followed by sedimentation and filtration for water from Lake Michigan. For two years the plant has exceeded its capacity, resulting from a 22 per cent population increase between 1950 and 1960. Also, 13 annexations totaling 550 acres were made during 1960; along with 38,000 ft of main laid in 1960 came 625 new customers. Plans and specifications have been prepared to provide an additional 20 mgd treatment plant capacity. Unfortunately construction, which will be started in June, 1961, will not be completed until 1963. It became evident that some means should be worked out to prevent a water shortage prior to completion of the new addition.



SCHEMATIC DIAGRAM showing how Kenosha plant will operate using Microstrainer in existing facility.

MICROSTRAINER PILOT PLANT shown installed in Kenosha water filtration plant. An average of 87 per cent algae reductions were accomplished during two months run.

Investigation showed that it was possible to push the plant to 25 mgd for a brief period. Short filter runs gave difficulty, similar to that encountered by other plants using Lake Michigan as a source of supply. Filter runs as short as two hours are not uncommon, caused primarily by algae whose numbers become troublesome in the raw water during peak demand periods. The problem could be partially solved, not practicably nor permanently, by increased detention periods in the coagulation basins. Since maximum use was being made of all existing facilities, it was decided to investigate the possibility of straining the raw water prior to filtration.

Pilot Study

Accordingly, negotiations were completed to obtain a Microstrainer* pilot plant, which was installed during July, 1960, and operated during August and September, 1960. The accompanying table provides pilot plant performance data. August and September are normally heavy algae months, but during 1960 we did not find the most adverse conditions, due to increased rainfall. In past years we have experienced three hour filter runs. In 1960, our shortest run was 12 hours, during which the filters were "bumped" three times. Bumping is resorted to in an attempt to get longer filter runs and use less wash water.

*Product of Glenfield and Kennedy, Inc., Harrison, N. Y.

Algae reductions through the pilot plant were amazing. Our pilot runs accomplished algae reductions varying from 56 to 97 per cent, with a two month average of 87 per cent, using two per cent waste water. The pilot unit was operated at 75 gpm. It contained a 2'6" dia x 2'0" wide drum, carrying a stainless steel screen. The screen is continually cleaned by water jets at 15 psi and cleaned at 20-35 psi operating for short periods. The pilot plant effluent could not be run to a sand filter, so it was not possible to completely reproduce operating conditions.

Full Sized Equipment Ordered

Pilot plant results demonstrated that the Microstrainer will remove the troublesome algae, so plans were prepared by Alvord, Burdick and Howson for the necessary basin. Also, four 10 ft dia x 10 ft wide Microstrainers have been ordered for delivery and installation for operation by June 1, 1961. Each of the four units will have Mark I stainless steel fabric, motor reduction gear, and manually controlled variable speed drive. The Microstrainers will be operated in such a manner that the maximum differential head across each drum will not exceed six inches.

Plans have been prepared to construct the required Microstrainer basin at the location shown on the flow diagram. Raw water is obtained from Lake Michigan by the low lift pumps which will deliver raw water containing no chemicals directly to the Microstrainers. Most of the algae and suspended matter will be removed by the Microstrainers instead of the former chemical coagulation process. We do propose to add aluminum sulfate, pre-chlorine, and activated carbon to our mixing tanks. This will be followed by the full detention capacity of our coagulation basins and utilization of all existing rapid sand filters.

Installation of the new Microstrainers in June should give us ample means to cope with the heavy algae and the high demands which occur during the late summer months. We propose to use the Microstrainer effluent water as Microstrainer wash water to help conserve filtered water. Also, it is expected that a chemical savings will be realized.

Plans have been made to install the Microstrainers in the future 40 mgd treatment layout. The Wisconsin State Board of Health has approved installation of this equipment, and we are planning to cooperate with them in a continuous sampling program and report observations of the equipment. The coming season should provide much operating data. We intend to make this information available to other plants faced with shortened filter runs and reduced capacity.

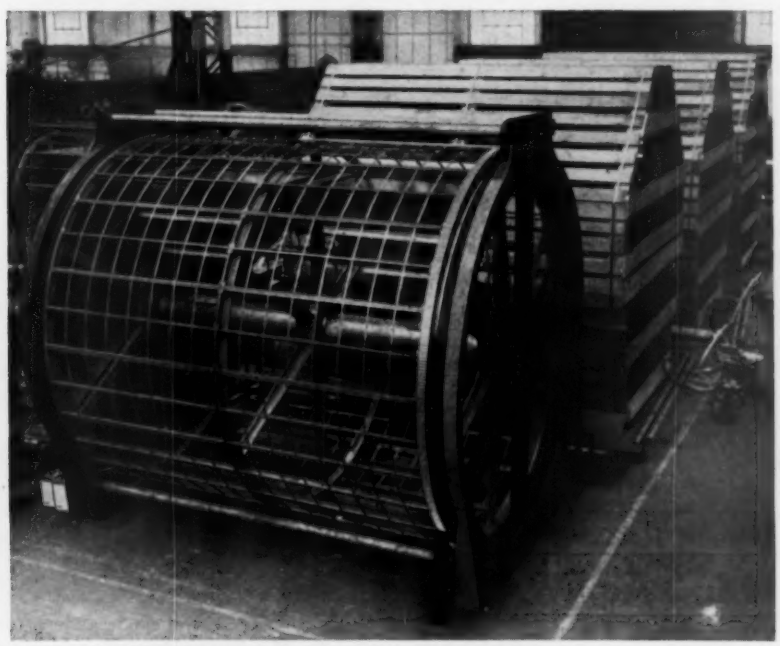
Microstrainer Pilot Plant

Performance Data

City of Kenosha — Water Dept.

Item	1960 August Max	August Min	August Avg	September Max	September Min	September Avg
Rate of Flow of Raw Water to Strainer (GPM)	75.0	66.8	73.9	74.5	62.8	70.1
Per Cent Flow of Waste Water From Strainer	4.4	1.5	2.0	4.3	1.7	2.5
Count of Microorganisms Per ml in Raw Water (Av. Std. Units)	384	98	214	2552	317	798
Count of Microorganisms Per ml Strained Water (Av. Std. Units)	83	7	33	224	45	93
Per Cent Reduction of Microorganisms Per ml	97	56	85	96	79	88
Turbidity of Raw Water (PPM)	14	3	8	22	4	9
Turbidity of Strained Water (PM)	12	1	6	17	1	7
Rate of Filtration (MGD)	24	12	16.4	21	12	17.2
Average Filter Runs (Hours)	38	12	28.4	40	19	27.2

PILOT PLANT performance data August and September, 1960.



FOUR MICROSTRAINERS ready for shipment to Kenosha, Wisconsin, filtration plant. Units are 10 ft diameter x 10 ft wide. Mark I stainless steel fabric will be installed at the plant site.

East Grand Folks, Minn., provides a lesson in . .

Installing a Sewage Lagoon and Lift Stations

by DONALD L. FLOAN
Consulting Engr.
Minneapolis, Minn.

■ ONE OF THE LARGEST sewage lagoons in the country went into operation in late 1960 with the completion of a modern sewage disposal system at East Grand Forks, Minnesota. Construction of the system was assisted by a $250,000 Federal grant.

Prior to the installation of the system, all of the domestic and industrial wastes from this City of 7,000 people were discharged without treatment into the Red River of the North. A rapidly growing population, plus recent State and Federal laws aimed at preventing and controlling water pollution, forced the modernization program.

With the new system, the flow of sewage is by gravity into one existing lift station and five new lift stations constructed as a part of this project. From these lift stations, flow goes through newly constructed force mains and gravity mains to a new master lift station from which it is pumped through a 30 in. diameter force main a distance of two miles to the site of the sewage lagoon.

History of the Project

Design contract date .....October 8, 1957
Bids Opened .....February 24, 1959
Contracts awarded .....April 7, 1959
Construction begun .....May 1959
Project completed .....September 1960

Selection of the Lagoon System

The lagoon type of treatment has received widespread acceptance throughout the upper Midwest in recent years because lagoons can be constructed simply and at a relatively low cost. They are capable of providing year-around effective treatment at extremely low operating and maintenance costs. It was for these reasons the lagoon type of treatment was selected for the City of East Grand Forks.

The Lagoon Site

In many respects, the same isolation requirements which are applicable in selecting a site for the so-called conventional type of treatment facility are applicable also in selecting a site for a sewage lagoon.

The site of the East Grand Forks lagoon is approximately 1½ miles north of the City on the East bank of the Red River of the North. Since the river flows north, the location selected permits the discharge of the treated effluent from the lagoon system at a point several miles downstream from the intake to the City's water treatment plant.

The lagoon system is located on a 380-acre site acquired by the City expressly for the purpose of constructing the treatment facilities. The system is comprised of a 240-acre primary pond followed by a 95-acre secondary pond. Discharge from the secondary pond goes directly into the Red River of the North. The size of the ponds leaves a considerable margin for future expansion.

Table I
Rising Level

Stop Elev.	Start Pump No.	Stop Pump No.	Pumps Running
Low Suction 791.50		Restore Pumps	
1 791.50	1	—	1
2 792.00	2	—	1 & 2
3 792.50 (to be set when future pump is installed)	3	1	2 & 3
4 793.00	1	—	1 & 2 & 3
Falling Level			
2 789.0	—	1 & 3	2
0 788.70	—	2	None
Low Suction 788.50		Stop All Pumps Manual or Automatic	

VICINITY MAP showing the location of the lagoon with respect to the City of East Grand Forks.

The Department of Health, State of Minnesota required that the storage capacity of the primary and secondary ponds should be sufficient to provide 180 days storage time for design winter sewage flows. The storage capacity of the primary pond is

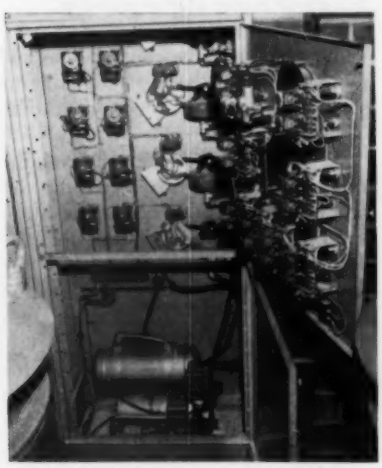
calculated as the volume between the minimum liquid level of one foot and the maximum liquid level of three feet, and the storage capacity of the secondary pond is calculated as the entire volume to a depth of three feet. Based upon present sewage flows, the system is capable of storing approximately 250 days of sewage flow. It was further required by the Department of Health that the 5-day BOD loading, during the season of maximum industrial waste discharge, not exceed 20 pounds per acre of water surface in the primary pond per day. Measurement of present sewage flows indicate the loading at this time will be in the vicinity of 8 to 10 pounds of 5-day BOD per acre per day.

Modern Lift Station Controls

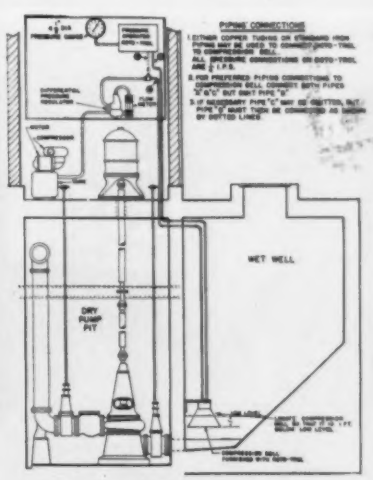
Specifications for the lift station controls called for the supplying of the motor control centers, associated control equipment and station heating, lighting and blower controls under a single contract. This action simplified the coordination of equipment and placing the system in operation. The control equipment was manufactured by Healy-Ruff Company of St. Paul, Minnesota. Motor starter equipment was manufactured by Square D Company of Milwaukee, Wisconsin.

Accurate control of the level in the wet well at each station is obtained by a self-purging bubbler system. Air from an internally mounted air compressor flows through a ¼ in.

MAP SHOWING locations of the lift stations and force mains installed as a part of the sewage disposal system.

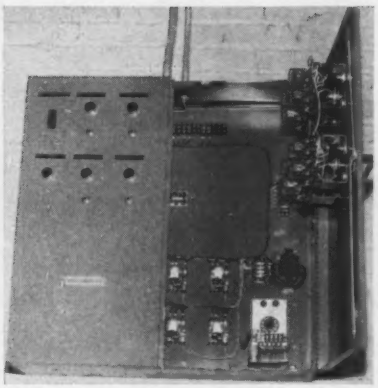


VIEW OF CONTROL cubicle at master lift station, showing bubbler controls and internally-mounted compressor.



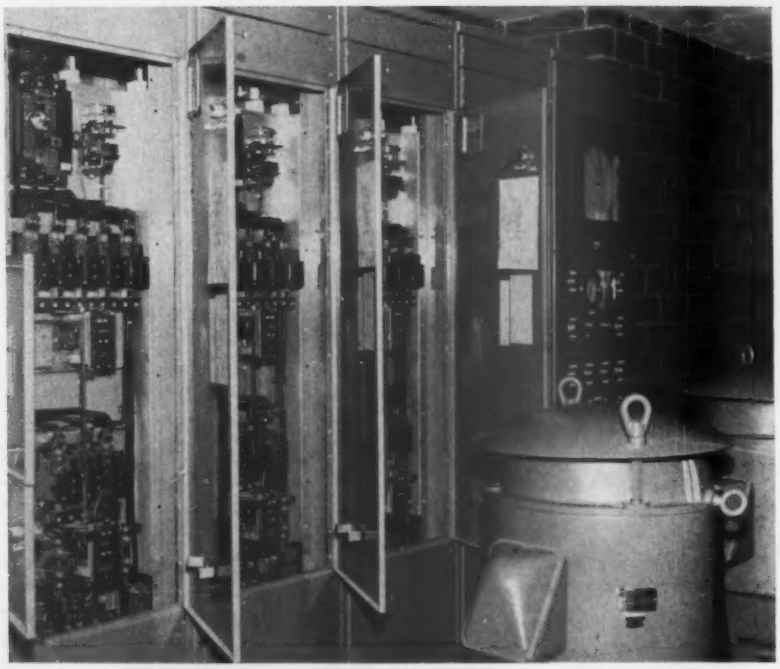
SKETCH SHOWING location of bubbler tube and compression bell in wet well.

CLOSE-UP of Healy-Ruff Control at master lift station.

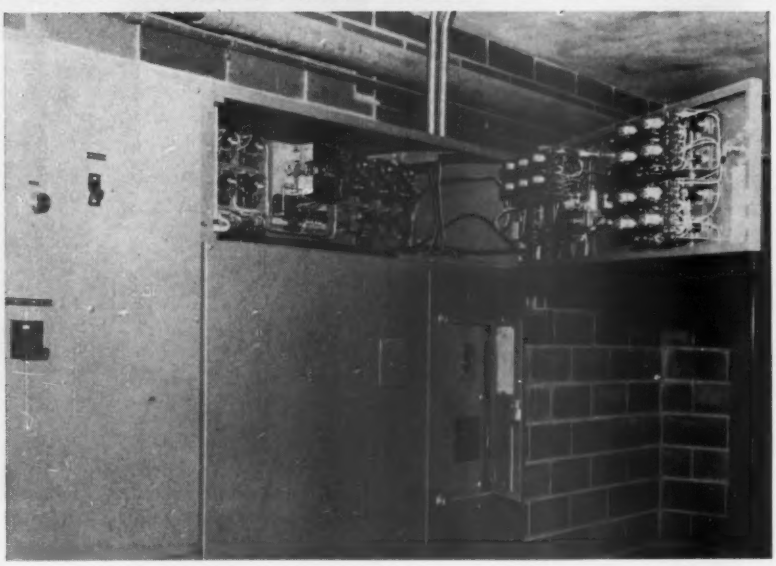


ALARM PANEL located in City water treatment plant.

(Above), EXTERNAL VIEW of master lift station showing modern, neat appearance.



VIEW OF CONTROLS and inside of Square D motor starter cubicles.



VIEW OF BUBBLER controls and timers at a typical lift station.

copper pipe extending from the control into the wet well to about 1 ft from the bottom. Variations in liquid level in the wet well produce corresponding variations in pressure required to maintain bubbling. The system pressure is always equal to the height of the wet well liquid above the end of the bubbler tube.

As the level changes in the wet well, pumping capacity is changed to match requirements. Individual pressure switches are set to detect each measured elevation for pump start, pump stop and alarm points. Sensitivity of the system is such that a change of ½ of 1 per cent of full range is sensed.

The action of the control is to add pumps or take them off the line as shown in the program of operation, Table 1.

At the low suction cut off level, the control automatically locks out all pumps regardless of manual or automatic control. Restoration of the pumping capacity required on the line is automatic when the elevation of the liquid in the wet well has risen to a preset level.

Each control includes an alternator to alternate two present pumps and changeable to 3-pump operation in the future by simply changing a switch-operating cam shaft.

MR. TIMOTHY SCHMALENBERG, Superintendent of Sanitation Department, for the City of East Grand Forks, Minn., shown at control panel in one of the lift stations.

OVERALL VIEW of controls and Square D motor starter cubicles at master lift station.

Master Lift Station

As mentioned above, flow from the various lift stations is accumulated at the master lift station. Here two 75 hp pumps and one 60 hp pump with a combined capacity of 8600 gpm provide the necessary lift to pump the sewage to the lagoon site. Provisions have been made for the addition of a future 75 hp pump when necessary.

Remote Alarms

The controls for each station include the necessary transmission equipment to transmit a common alarm to the remote alarm station located in the City Water Treatment Plant. The common alarm for any particular station is sounded in the event of: 1. pump failure, 2. high wet well, 3. low wet well, 4. compressor failure, 5. low suction lockout or 6. station power failure.

Provision for Future

The system as constructed incorporates provisions for additional lift stations as well as for additional pumps at 4 of the 5 newly constructed stations.

With these provisions, design calculations indicate the system can accommodate a population equivalent of 28,300 people.

DIS *organization* Man

CONTINUED FROM PAGE 172

So endeth the lamentable day of the dis-Organization Man; and so, without much unwillingness, did this man come back to his typewriter. To be sure, it has its failings, but by and large and more or less approximately it does get down the general sense of what I want to say. When I stop, the typewriter stops; when I start again, so does the typewriter. It doesn't mind if I stop to Think; it doesn't jump about if I happen to spill tea over it; it doesn't cough back when my cigarette smoke rolls over it—best of all—it doesn't Look. When I stop dictating to a secretary she Looks. Looks come out from her in all directions, and the more she Looks the less I am able to Think, and the less able to get started again. I find it irritating—no I don't, I find it drives me nearly insane. I am not even able to put up with anyone who Peeps while I am trying to work. Peeping is purposeful aggravation, and people who Peep I would throw out of the room, if only I weren't such a coward. People who Look are sadists.

And when you do dictate to a secretary you don't do it "to" at all; you do it "into". All your words seem to fall soundlessly into a bottomless pit, or a well full of feathers. You get no sense that what you are saying now has anything at all to do with what you were saying a few sentences back. Indeed, with a mind like mine, there may possibly be no connection at all. Funny thoughts might strike me when I am trying to write a sober report (they most often do). I might get so carried away that I would send my kindest regards to the Income Tax Inspector, or sign myself 'your loving son' to my employers (a contingency they might not have insured against), or I might assure my mother-in-law I was her 'obedient servant'. Dear me, the risks aren't worth the trouble involved.

Flint, Michigan, Carries Fund Needs To TV

The need for water and sewage treatment plant expansion in Flint, Michigan, was carried to the people via local Station WJR-TV on Sunday, February 5, 1961.

The program, "In Our Opinion", was moderated by announcer, Frank Benesh, and interviewed Mr. Henry Foley. Mr. Foley, Consultant to Flint's City Manager, discussed the need for increasing Flint's water supply, expanding the treatment plant, increasing flow in the Flint River, and providing additional capacity at the overloaded sewage treatment plant.

Repairing Steel Pipe

The Hard Way

by Kurt A. Gruber
Chemical Fire and
Rust Proofing Corp.
Great Neck L.I., N.Y.

A difficult, and sometimes dangerous, job of repairing a steel pipeline in the Florida Keys provides valuable information toward solving rust and corrosion problems, particularly in those lines installed in Tropical areas.

■ ANYBODY WHO HAS ever motored from Miami, Florida to Key West, along the Overseas Highway, has probably noticed a steel pipeline running either alongside the roadway or on trestles parallel to some of the bridges connecting the Florida Keys. It is an 18 in. and 20 in. line running from a pumping station at Florida City to the Key West Naval Shipyard. The line installed in 1941, is owned by the United States Government which operates it through the U. S. Navy Aqueduct Office at the Navy Yard in Key West.

The importance of this line can be understood when it is realized that it is the sole source of water supply, not only to the Navy Yard which is a vital link in the Continental Defense System, but also to the entire civilian population of the area.

The Florida Keys Aqueduct Commission, a civilian agency, buys the water in bulk from the Navy and distributes it to the individual user. There are almost no wells in the area, nor any other source of fresh water. Storage tanks contain a sufficient reserve for about one day's needs. Depending on the time of year, three to six million gallons of water are pumped through the line every day. Thus, any major breakdown or tie-up of the line represents a critical hazard to the health of the people of the entire Florida Keys area.

Along its approximately 130-mile path, the line is exposed to some of the severest corrosion and erosion conditions imaginable. About 70% of the line runs underground in a bed of coral rock or swamp, exposed at all times to the high water table of salt water. The rest of the pipeline is suspended from bridges which connect the Keys, including the well-known Seven-Mile Bridge, or runs on trestles from 3 ft to 20 ft above the ocean or swamps, exposed to wind, weather and salt water spray. On only one stretch of about 5,000 ft is it fairly well protected against the elements by being placed in a sheltered position on the Bahia Honda Bridge, a former railroad bridge. There the pipe is about 40 ft above the ocean, and on the inside of the bridge structure, below the bridge deck.

When the pipe was installed 18 years ago, it was coated on the job site in Florida by spin-lining the inside surfaces with hot bituminous enamel. The outside received a coat of enamel with one wrapper of pipeline felt. The extremely aggressive corrosion conditions prevailing and the fact that the black outer surface of the pipe soaked up the heat and sunshine of the sub-tropical climate caused the exterior surfaces of the line to deteriorate quickly. Yet the inside, continuously filled with water, is almost completely intact to this day.

To maintain the line the Navy set up a permanent maintenance program with the necessary personnel, including welders, painters, etc. Despite their best efforts, the deterioration of the exterior surfaces proceeded faster than the repair crew could fix it. Water accumulated under the coating by entering through cracks in the enamel and formed large blisters. The steel began to pit excessively, and leaks developed more and more frequently.

The Navy decided several years ago to rehabilitate the entire line as far as all exposed areas were concerned, and to install a cathodic protection system for the protection of the underground sections of the pipe. This work was let in several increments with the installation of the cathodic protection system representing one undivided contract, and the cleaning and coating of all exposed sections to be performed in four separate contracts.

While the three previous contracts pertained only to pipe suspended from bridges, the last increment involved pipe installed in a variety of locations, positions and exposures.

A large section of this work, about 35,000 ft, was on a 3 ft high trestle running in a fairly straight line along the highway, but above swamp, coral rock, open water, or, with infrequent convenience above solid *terra firma*. The vegetation and animal life was varied. Cacti, high stubborn grass and jagged coral were prominent as well as mosquitoes, as large as horseflies, which caused each workman to bathe himself several times daily with insect repellent. The alligators, appearing every morning near the rafts where the work was performed, were at first an object of curiosity and occasional scare, but later on were taken for granted. Also taken for granted were the 100-mile-an-hour drivers who sometimes passed within a few feet of the trucks and compressors, completely disregarding the numerous 15 mph warning signs.

In seven or eight locations, the pipe was placed on trestles about 15 ft to 20 ft above the open water, and between 50 ft and 100 ft from the bridges where the trucks and compressors had to be parked to follow the men working on the catwalk scaffold. The current underneath the trestles and bridges was swift at all times and extreme caution had to be observed to keep men and equipment from falling into the water.

Because a large part of the exterior coating was in good condition and well bonded, the specifications called only for removal of the loose and poorly bonded coating of the pipe. This varied, depending on the location and exposure of the pipe from 10% to 100% of the surface area. At first the entire pipe surface had to be tapped and chipped in order to find and remove the loose felt and enamel. After this operation, all bare but rusty pipe surfaces had to be sand blasted. This accomplished, inspection of the bare metal showed a varied degree of deterioration. Many times the sand blasters actually blasted holes through the pipe because its wall had rusted away to almost paper thickness.

Prior to priming the bare metal, Navy welders had to repair the pipe either by welding steel patches on the deeper pits and holes or by applying a heavy coat of a special mastic compound consisting of epoxy resin filled with metal particles. The contractors had to repair nearly 1000 mechanical couplings by replacing the deteriorated rings and bolts. All this repair presented added problems of delay, since the sand blasted surface, if left uncoated overnight, would rust up again. It was finally decided to prime the pipe immediately after blasting, but before repair.

Prior to the application of the hot bituminous enamel, another coat of bituminous primer was sprayed on. No felt wrapper was specified, but three coats of cold bituminous coating were applied on top of the hot enamel. The last coat contained aluminum powder, giving the entire pipeline a bright sunlight reflecting finish. Bituminous primer and enamel were applied only on the bare sections, but the three finish coats of cold bituminous coating were applied on the entire pipe surface. The total thickness of coating averaged about one-quarter of one inch.

This thick protective coating, in combination with the continuing maintenance by Navy personnel, should protect the line for a good many years to come. The mechanical couplings, after repair of the rings and bolts, were contained in a fiber mold which was then filled with hot coal tar enamel.

It was generally felt that the coating specifications, outlined above, were not the best ones for the prevailing conditions. However, since the entire pipe was not stripped to bare metal, the Navy engineers had to continue using bituminous coatings in order to accomplish the necessary bond between the old and newly applied materials. About 1000 ft of the pipe was stripped and sand blasted completely to bare metal, and the Navy forces will use this section to test a variety of coatings, including the newer types of synthetic resins. Its result will be interesting to watch, and will undoubtedly be most helpful to the corrosion engineers when specifying protective coatings under similar conditions in the future.

New York City's Public Works Department Annual Report 1960

New achievement records in the design and construction program of New York City's Department of Public Works during 1960 are indicated in reports covering some 150 projects with contract values in excess of $200,000,000, according to the Department's Annual Report for 1960.

The value of work performed under all contracts last year was $60,078,383, almost $4,000,000 more than anticipated. The construction contract value of design work completed is $79,797,525 or $14,775,000 more than had been estimated at the beginning of the year.

In the Pollution Control Program, twelve modern sewage treatment plants and two obsolete screening plants staffed, operated and maintained by the Bureau of Sewage Disposal Operation, reached a new high.

803 million gallons of sewage was treated daily, of which 700 million gallons per day received complete secondary treatment.

During 1960, 103 million cubic feet of sludge was produced by the treatment processes. 75 million cubic feet underwent anerobic digestion to yield 43 million cubic feet of digested sludge. All the undigested raw sludge, 28 million cubic feet and 36 million cubic feet of digested sludge was transported to sea by self-propelled motor vessels.

The remaining 7 million cubic feet of digested sludge was delivered by pipeline or a specially equipped sludge vessel to the Park Department for the production of synthetic topsoil.

1960 Annual Report of Indianapolis Water Company

Gross revenues for the Indianapolis Water Company were $10,460,857 for 1960, exceeding 1959 revenues by $55,177, according to the company's 1960 Annual Report.

Operating expenses were $7,589,392, only $289 over those of the previous year.

Pumpage for the year totaled 24,892,000,000 gallons, a decrease of 495,950,000 gallons, or two per cent, from the record year of 1959.

The high monthly pumpage was 2,496,670,000 gallons in August. The daily average usage of water was 68,010,000 gallons. The year's maximum day pumpage was 98,310,000, which occured in September.

In 1960 the Company spent $4,257,552 for capital improvements to its plant.

Danville, Virginia, Water, Gas and Electric Departments, 1960 Report of Operations.

Operating revenue for Danville, Virginia's Water Department totaled $511,125 for 1960, an increase of $110,022 or 27.4 per cent over last year, according to the Danville, Water, Gas and Electric Department's 1960 Report of Operations.

The major contributing factor to the increase in revenue was the 20 per cent raise in rates which the council approved effective Jan. 1, 1960. Revenue exceeded budget expectations by $52,624, for the year.

The net income of $114,479, also effected by the rate increase, was $84,723 for the year. The department lived within the budget appropriation, with $15,180 to spare in operating expenses.

An average of 12,824 customers were served during the year with an increase of 365 over 1959.

The maximum daily system demand reached 7,880,000 gallons per day as compared with 7,600,000 gallons during the previous year. This is 87 per cent of the designed rated capacity of the water treatment plant.

The system demands of 229,024,000 cubic feet of water occasioned a 4.4 per cent increase in water production over last year.

Compressed Air Revives Polluted Swedish Lakes

By WILLIAM A. HEATH

■ THE GREATEST pollution problem in Sweden, a country with one of the highest living standards in Western Europe, is polluted lakes. This is the cause of great concern to the Swedish public health authorities, for many of Sweden's lakes are polluted to an excessive degree. Some, which once bubbled with vitality and were so beautiful to look at, and to bathe in, have lost their freshness completely.

The water smells musty: it cannot breathe. The fish and vegetation which once abounded are dying out. And Swedish lakes, once an excellent source of domestic water, are now in many cases grey, dead and dirty.

Obviously these natural resources, of great value to the Swedish people, cannot be allowed to waste away. Realizing this fact, the public health authorities have embarked on a program by which it is hoped that the polluted lakes will breathe again.

In the summer of 1959 the program got under way at a small, idyllic lake called Langsjon. This lake had gone completely sour, dissolved oxygen being completely absent, and incapable of supporting plant or fish life. Lake Langsjon was in such a bad state that the Swedish organization which is concerned with the preservation of rural amenities complained to the local authority.

An engineer employed by Industriforbundets Vattenvardsbyra, Mr. Leif Bruneau, was called in to help. For some time previously Mr. Bruneau had been experimenting with compressed air as a means of purifying polluted water. He enlisted the help of Atlas Copco, the international firm of compressed air engineers, to try out similar methods at Lake Langsjon and a system was evolved which may solve the problem of polluted lakes. A perforated plastic hose, 500 meters long, was weighted at intervals and laid on the lake bottom from a row boat. Air was pumped through the hose using a small compressor consuming 8-10 hp. After less than three weeks the dissolved oxygen content of the water in Langsjon Lake had risen 57 per cent and there was a well established growth of new plant life. When treatment began a temperature difference of 12 degrees C. existed between the water at the surface and that at the bottom of the lake. In three weeks the turbulence induced by the compressed air erased that difference.

The onset of the winter of 1959-60 caused operations to cease until the spring of this year when the work of rehabilitating the lake has again proceeded satisfactorily.

The results are so encouraging that a similar method of treatment is to be applied to most of Sweden's polluted lakes. While the engineers and scientists engaged on the Langsjon project are careful to say that the case for compressed air treatment should not be overrated. They nevertheless are convinced that the results achieved point to the fact that the method is the most useful in solving problems of acute pollution, especially if it precedes the construction of an efficient purification plant.

The water is oxygenated not by the compressed air itself, but by the waves created by the pumping action of the air as it forces its way to the surface. The waves pick up oxygen from the atmosphere and hence the program has become known among those engaged on it as a program of "self-help".

Release of hydrogen sulfide, which may be present in the lower layers of stagnant water and could cause the characteristic odor in the neighborhood, is avoided by sampling the water at different levels.

A point to be resolved is whether treatment should continue throughout the winter months. Compressed air purification closely resembles the method adopted for keeping channels ice-free successfully used in the United States, Canada, Greenland and Sweden. In Sweden, where ice-skating is a national pastime, the prevention of ice formation may not earn the total approval of skaters. However, if treatment must cease during winter, when spring returns the pipe is ready in place to continue its job of helping the lake live again.

THE PERFORATED HOSE is inspected before being paid out on the lake bed.

THE LAKE LEARNS to breathe: air bubbles rising to the surface as compressed air is pumped through the pipe and rises to form waves.

Coagulant Aids As Filter Aids

by W. R. CONLEY and
R. W. PITMAN,
Research and Engineering Section,
Hanford Atomic Products Operation,
General Electric Company

■ THE HANFORD WATER treatment plants were operated for a number of years using alum as a coagulant and activated silica as a coagulant aid. In 1957, the plants were converted to a new process using alum as a coagulant and a polyacrylamide as a filter conditioning agent. Sufficient time has elapsed to make a comparison of the two methods of operation valid and useful.

A coagulant aid, activated silica, was used successfully with alum at Hanford to produce high quality water at high filter rates. Cost of the method was high and control of the method was difficult.

A new low cost process was developed at Hanford and the silica process was abandoned in 1957. The new process has saved over $750,000 in chemicals since its adoption. Water of improved quality has been produced by the new process and filter rates are higher than the silica process.

The new process uses alum as a coagulant. Following coagulation and settling, settling is not necessary in the Hanford scheme, a few parts per billion of polyacrylamide are added to the water as it enters the filters. The polyacrylamide adheres to the filter media and to the alum floc. Filter breakthrough is controlled and water quality is excellent.

The new process has proven particularly valuable in making high rate filtration practical. Operation with the new process at high rates is easier even than with the old process at low filter rates. Some Hanford plants are capable of producing considerably more filtered water than they were designed for. This increase was accomplished without any basic changes in plant structure.

Coagulant Acids

Alum reacts with the raw water to produce a floc. This floc is a complex material containing the suspended matter from the raw water and hydrated aluminum oxide along with various ions such as sulfate, chloride, etc. Sometimes the floc forms quickly and settles readily in equipment designed for this purpose. At other times, the floc forms slowly and settles with difficulty.

It has been generally and erroneously assumed that floc must be well formed and must settle readily in order to achieve good filter plant operation. Where the floc does not form readily with alum, various coagulant aids have been used with the alum to improve floc formation. The use of activated silica, discovered by Baylis, continues to be the most widely used coagulant aid. Various organic polymers can also be used for this purpose but are generally too expensive to be used on a large scale.

Filter Conditioners

Conditions such as cold raw water, high filter rates, and high coagulant feeds encourage the floc to penetrate through the filter beds and appear in the effluent water. This is called breakthrough.

In the course of experimental work in a small filter plant, the authors discovered breakthrough can be controlled by feeding from 1 to 20 parts per billion of various chemicals to the water entering the filters.[1] The process was developed and applied to large scale filtration at Hanford.[2] The value of the process is that it results in production of exceptionally clear water at exceptionally high rates and at exceptionally low cost. Coagulant aids are eliminated, but alum feed is retained with the process.

The theory of the action of the filter conditioner is the agents act to bond the alum floc particles to the filter grains and to each other. The agents act as a glue. The action of the agent now used is very efficient. If more than 30 parts per billion are fed, the rate of head loss increase on the filters is excessive. For this reason, an understanding of the reaction of the materials and a logical method of chemical control is essential.[3, 4]

Plant Experience with Activated Silica

The silica was activated with sulfuric acid according to the method of Baylis. The use of the activated silica caused a remarkable improvement in alum floc appearance and in settling rates. Filtered water turbidity was reduced by use of activated silica. Operation at high rates without breakthrough at water temperatures below 10° C was not possible without the use of activated silica. In all cases during a period of over five years and at each plant, the activated silica always caused an increase in filter head loss roughly in proportion to the amount of silica feed.

It was necessary to feed from one to four ppm of activated silica to get the required results. This represented an annual cost of over $250,000 a year at Hanford.

The equipment needed to prepare activated silica is expensive and correct operation requires a competent technician. The correct preparation of the materials is probably the most difficult job required of the filter plant operators.

In spite of the high cost and complexity of operation, activated silica proved to be highly successful at Hanford. The material made it possible to make high quality water at fairly high treatment rates.

Plant Experience with Filter Conditioners

During 1956 and 1957 all of the Hanford plants were converted to the new filter conditioning process and the activated silica process was abandoned. Considering the magnitude of the process change, the transition was made with remarkably little difficulty.

The most striking aspect of the new process in plant operation was the ease with which the operators could produce clear water at high treatment rates with rapidly changing raw water conditions.

Operating cost of the new process proved to be less than expected. Not only did the new process eliminate the cost of activated silica, it also reduced the alum feed. Total savings from the new process have been over $250,000 per year.

Elimination of silica feed greatly simplified alum dosage regulation. When silica was fed there were a number of combinations of alum and silica which would give fair results, but it was difficult to determine the combination which would give optimum results. When silica was eliminated, only alum remained as the coagulant, and the optimum dosage was easier to determine. Filter conditioner dosage is easy to estimate providing a method is available for measuring individual filter effluent turbidity quickly and sensitively. The method used at Hanford is described in reference[4].

Although an overdose of 100-200 per cent can be tolerated in filter conditioner feed rate, excellent results cannot be obtained unless the feed is regulated to assure no more than a 25 per cent overdosage. An overdosage, unless extremely high, causes an increase in the rate of head loss buildup on the filters. In practice it is very easy to control the feed to within ±10 per cent of any desired value. The practice is to feed just enough material to prevent an individual filter from breaking through at a head loss of six to eight feet. This amount varies from 0.001 to 0.03 ppm depending upon raw water conditions and the filter media composition.

Another advantage of the new process is the small size and simplicity of the equipment needed to prepare and feed the chemical. For our large plants, the filter conditioner equipment cost was less than 10 per cent of the cost of the activated silisa equipment.

Conclusions

After a number of years of plant operating experience with activated silica as a coagulant aid and organic polymers as filter conditioners, the following conclusions have been reached:

1. Filter conditioners give better results than coagulant aids.
2. Filter conditioners reduce operating costs significantly.
3. Personnel can be trained in filter plant operation much faster when using filter conditioners than when using activated silica and alum, or alum alone.
4. Plant capacity can be increased by the use of filter conditioners.

Limitations

The method of using filter conditioners at Hanford has been worked out in detail for Columbia River water. Other waters may require modification of the process for optimum results. Personnel at Hanford have been trained for many years to control plant operation by measurement of filtered water quality. This kind of control is ideal for the filter conditioner process.

Personnel trained in other methods such as floc test control or floc appearance control would have to be retrained before the Hanford methods could be used successfully.

References

1. HW-45006, Conley, W.R., Botsford, C.W., Pitman, R.W., "Hanford Use of Experimental Water Filter Plant."
2. HW-60311, Richman, R.B., "Improvements in Water Treatment for Once Through Reactor Cooling."
3. Conley, W.R. and Pitman, R.W., "Test Program for Filter Evaluation at Hanford," JAWWA **52** February, 1960.
4. Conley, W.R. and Pitman, R.W., "Innovations in Water Clarification," JAWWA **52** October, 1960.

National Congress on Environmental Health

The National Congress on Environmental Health will be held at the University of Michigan School of Public Health June 6-8, in Ann Arbor.

The Congress provides a forum for leaders in industry, public health and the general public to explore together the resources in man's environment and the maximum uses of them in terms of the needs of industry, government and conservation in keeping with health, social and economic trends.

Among the notables scheduled to address the Congress are Dr. Thomas Francis, Jr. of the U-M; Hon. John E. Fogarty, congressman from Rhode Island; Walker Cisler, president of Detroit Edison Co.; Dr. Luther Terry, the new surgeon general of the U. S. Public Health Service; and Dr. Leona Baumgartner, commissioner of health of New York City.

The three-day program will have sections emphasizing scientific advances; the requirements of industry, conservation and health; and methods for developing environmental resources. Invitations have been sent to industrial, scientific and public health leaders throughout the United States to draw a representative cross-section from all interested organizations.

More than 150 persons attended the first Congress which was held at the U-M in 1959, and a greater number is expected for the forthcoming session. The National Sanitation Foundation, the U-M School of Public Health and the American Public Health Association sponsor the meeting. Dr. Henry F. Vaughn, dean-emeritus of the U-M School of Public Health and president of the National Sanitation Foundation, will be general chairman.

Water Resources in Connecticut; Report Published

A Progress Report covering 1955-1958 has been published by the Connecticut Water Resources Commission in cooperating with Geological Survey, United States Department of Interior. The report is entitled "Chemical and Physical Quality of Water Resources in Connecticut—1955-1958."

A program to appraise the chemical and physical quality of surface and ground waters in Connecticut was started in 1955 by the U.S. Geological Survey in cooperation with the State Water Resources Commission.

This report is the first in a series of planned reports on the chemical and physical quality of water resources in the state. It contains results of the investigation through 1958.

Editorial

A Lesson and a Moral

Last month we referred to the impact which might result from increased public awareness of problems facing water supply and pollution abatement programs. Attention was invited to the necessity for being certain that all possible attention be given to efficient operation by local officials. While we were concerned primarily with proposed new and system expansion projects, it is clear that simple day to day attention to details is mandatory.

A case in point reached the public press in mid-March. Reports datelined Jersey City, N. J., recounted the pathetic situation in this community's sewage treatment system. Deterioration had progressed to the point that more than $3 million will be required to correct component malfunction, recondition sewage plants only four years old, and to refurbish the interceptor system. This sort of public attention is exactly the opposite of the need in this field.

Specific areas of incompetency uncovered by the investigating consultants include improper operation and maintenance of the interceptor system and the treatment plants, plant components which never operated and others which are incapable of operating as intended. Further, administration was ineffective and wasteful, no solicitation of additional sewer connections was being attempted, nor was any capital improvements program in effect. Despite all this, the system effluent met minimum standards established by the Interstate Sanitary Commission. The upshot is that the Jersey City Sewerage Authority has fired its consulting engineer, its chief engineer and superintendent, and three other management level personnel.

The situation raises questions, of course: Where does the responsibility lie? What sort of employment practices permit promotion of personnel into and retention in responsible positions over a period long enough to create the deplorable conditions reported? How many other sewage systems might fall into the same pit when subjected to outside, authoritative, unbiased inquiry and inspection?

It is unfair to judge all sewage systems on the basis of this one staggering example. But it is fair to broadcast the message widely among ourselves to hammer home the point that we all, from the smallest to the largest, must be able to stand close scrutiny.

Our industry cannot, at this point, stand adverse criticism of operation and maintenance. We stand on the threshold of greater strides in pollution abatement than have ever been made before. But, as has been pointed out here before, attention must be paid to efficiency of operation at all levels, utilization of proved technical advances, incorporation of modern equipment, and assignment of capable, dedicated personnel. It is in this latter area of personnel employment and utilization that extreme caution must be observed.

One last point deserves mention. The design, materials specification, and construction of new and expanded facilities must be particularly free of any taint whatsoever. Recent localized incriminations in the highway program are not pleasant to the program-supporting, taxpaying public. There must be a lesson and a moral in these examples.

V. W. Langworthy

Tastes and Odors, Iron, Manganese and Hydrogen Sulfide are removed using . . .

New Potassium Permanganate Techniques

by S. BRUCE HUMPHREY, Manager
End Use Department and
MAURICE A. EIKELBERRY, Chemist
Carus Chemical Co., LaSalle, Illinois

■ Potassium permanganate was introduced as a water treating chemical by Sir Alexander Houston in 1913[1-6]. Obnoxious tastes and odors characterized as "iodoform" were destroyed by potassium permanganate. "Potassium Permanganate has the advantage that it is in small doses *per se* a taste remover, not a taste producer".

In this country potassium permanganate was used as early as 1927 by J. M. Caird, Rochester, New York, again to combat foul tastes and odors[6, 8]. H. F. Huy of the Western New York Water Company started potassium permanganate treatment in 1928 in Buffalo, New York to treat water polluted by coke plant wastes (phenols)[6-8]. Sciota River water was treated with potassium permanganate by R. D. Scott, chief chemist of the Ohio Department of Health to eliminate tastes and odors[9]. Phenols, allied compounds, decomposition and cleavage products of organic matter responsible for foul tastes and odors were successfully removed by potassium permanganate, according to L. B. Harrison of the Bay City Michigan Water Works[6, 9, 10].

Potassium permanganate for water treatment was discontinued during World War II due to lack of availability[15]. Research and development has recently lead to improved manufacturing techniques making potassium permanganate available in unlimited quantities.

Manganese Zeolite Regeneration

For many years potassium permanganate has also been used to regenerate manganese zeolite and manganese treated greensand[11]. This process is simple and subject to a minimum of chemical deviations. The manganese treated greensand process is a soluble iron, manganese and hydrogen sulfide remover and the mineral is regenerated by potassium permanganate. Manganese treated greensand is made from refined and processed natural greensand by alternate treatment with solutions of a manganous salt and potassium permanganate. It is a black, granular material, serving both as an oxidizing contact medium and as a filter medium.

For small industrial, small municipal, and household uses, manganese treated greensand filters will remove soluble iron and manganese (10 ppm) and hydrogen sulfide (6 ppm).

For large water treatment systems, the manganese treated greensand process is usually limited to removal of soluble iron and manganese from water containing 1 to 2 ppm or less than these quantities. This process is applicable for industrial process waters which do not require softening but have troublesome amounts of soluble iron and manganese. Another application is the treatment of certain waters that are low in total hardness and pH and contain small amounts of soluble iron, manganese, and hydrogen sulfide[12-14].

New Method

The manganese treated greensand process for soluble iron, manganese and hydrogen sulfide removal has recently been revolutionized. In contrast to the previous "indirect type" process, the method recently developed[16] and currently in use involves continuous addition of a 1 to 4 per cent potassium permanganate solution ahead of a manganese treated greensand filter topped with several inches of anthracite coal filter medium. The senior author, in cooperation with L. W. Marvin and N. A. Gustafson of the Colchester, Connecticut Water Department first tried the continuous feed of potassium permanganate solution ahead of manganese treated greensand filters in March of 1960. Potassium permanganate replaced a hypochlorite solution which was incapable of oxidizing organic iron complexes. This new technique was later perfected by those mentioned above and Richard Fackler of Hungerford and Terry Company and approved by the Connecticut State Department of Health.

In small systems where manganese treated greensand pressure filters are used, potassium permanganate is applied as a 1 to four per cent solution using positive displacement proportioning pumps of either diaphragm or piston design depending on the pressures involved. The permanganate solution should be introduced as far ahead of the filter as practical.

This method oxidizes soluble iron, manganese, hydrogen sulfide and some organics. Resulting insoluble products are removed by the filter.* The distinct advantages of this continuous process are:

1. No down time for regeneration of manganese treated greensand.
2. Minimum down time for backwashing.
3. Generally longer service runs (limited only by pressure drop on the filter).
4. All of the potassium permanganate is utilized thus effecting a chemical savings.
5. More efficient and consistent removal of a variety of contaminants.
6. Utilizes present equipment in most cases.
7. In no case is expensive or elaborate equipment required.
8. More readily automated.
9. Potassium permanganate solutions are not corrosive permitting use of common and inexpensive materials of construction.
10. The precise potassium permanganate dosage is easily determined visually (one can readily detect concentrations less than 0.05 ppm potassium permanganate).
11. Requires no special operator training or analytical techniques.

Conventional Large Water Treating Systems

Potassium permanganate serves admirably for solving two difficult problems namely: stain-causing iron and manganese and taste and odors.

In conventional water treating systems employing pretreatment, coagulation, flocculation, sedimentation, filtration and post treatment, potassium permanganate is conveniently utilized.

Potassium permanganate will oxidize soluble divalent iron and manganese as well as their organic complexes to the corresponding insoluble oxides. During the course of this reaction the potassium permanganate is reduced to insoluble manganese dioxide hydrate which functions as a coagulant and as an adsorbent. The reaction is nearly instantaneous; however certain soluble organic iron and manganese complexes may require as much as ten minutes. Using potassium permanganate as an oxidant there are no limits as to the amount of soluble iron or manganese that can be oxidized.

Tastes and odors caused by industrial wastes, agricultural chemicals, fish poisons, decayed vegetation, algae, actinomycetes, etc., are removed by oxidation and adsorption using potassium permanganate.

Potassium permanganate will destroy tastes and odors characterized as musty, earthy, woody, grassy, fishy, medicinal, chemical, iodoform, etc. These tastes and odors are caused by a vast mixture of organic compounds most of which have not been identified. However, analysis of carbon filter extracts indicate the presence of organic acids, aldehydes, ketones, nitrates, alcohols, esters, carbamates, mercaptans, olefins, etc.

The type and size of plant dictates the technique of permanganate addition.

In large systems the chemical is conveniently handled with dry feed equipment and a dissolving tank. The solution can then be pumped or fed by gravity to the rapid mix chamber[15]. Depending upon the situation, potassium permanganate solution is added before, after or in conjunction with other pretreatment chemicals. Potassium permanganate is compatible with all typical pretreatment chemicals and in many cases they compliment each other.

Reaction time is an important consideration depending upon the nature of the contaminants. Therefore, this will frequently dictate the point of application of the potassium permanganate solution.

Our experience indicates that manganese dioxide formed *in situ* serves as a coagulant aid thus minimizing coagulants such as alum, ferric sulfate, etc., by as much as 60 per cent.

Review of Current Applications

Peru, Illinois instituted potassium permanganate feed in an effort to overcome an average of 12 to 20 consumer complaints per day. Superintendent Panzica reports 0.3 ppm of $KMnO_4$ maintains the palatability of the lime-soda softened well water[17]. A diaphragm proportioning pump and crock constitute the feeding arrangement at this plant. A two per cent stock solution of potassium permanganate is pumped from a container into the raw water, followed by lime, mixing, flocculation, sedimentation, recarbonation, and filtration. The filtered water is post-chlorinated. This system now receives no complaints.

Waxahachie, Texas started up their new water treatment plant during 1960. Raw surface water is stored in a reservoir and decaying vegetation caused treatment problems resulting in complaints of tastes and odors. Activated carbon formerly used at the rate of 500 lbs/day, has been reduced to 70 lbs/day since the feed of potassium permanganate was started, according to J. L. Smith, Superintendent[18]. A small diaphragm proportioning pump applies $KMnO_4$ to the raw water at the low lift pump discharge. The raw water transmission line provides 4 to 5 hours detention time en route to the filter plant. Interestingly, start-up of the potassium permanganate system was followed by slime removal from the interior of the raw water piping. At the plant, water receives pre and post-chlorination, lime, alum or ferrous sulfate and activated carbon as noted above.

Royersford, Pennsylvania water treatment plant uses potassium permanganate to eliminate consumer complaints of color, stains, tastes and odors. A positive displacement pump provides $KMnO_4$ at the rate of 1.4 ppm in the winter and 1.0 to 1.2 ppm in the summer. S. J. Campbell reports that use of activated carbon and chlorine dioxide dosage have been discontinued, and that alum requirements have been reduced by as much as 15 per cent[19]. Further, he states that copper sulfate application for algae control is no longer required. Treated and filtered water receives post-chlorination.

*This unit serves as a filter as well as a "buffer". For a given dosage of potassium permanganate and constant soluble iron, manganese, hydrogen sulfide and organic content, this unit will function indefinitely requiring only periodic backwashing as determined by pressure drop. In practice soluble iron, manganese and hydrogen sulfide content is not constant but fluctuates. Also, feeds will vary slightly because of mechanical imperfections of equipment. The manganese treated greensand is capable of removing unoxidized soluble iron, manganese and hydrogen sulfide when the potassium permanganate dosage is too low. In contrast, if the potassium permanganate dosage is too high, the manganese treated greensand consumed the excess potassium permanganate thereby regenerating itself.

Colchester, Connecticut uses potassium permanganate continuously in their manganese treated greensand pressure iron removal filter plant. No complaints have been received, according to L. W. Marvin, Superintendent, and backwash water requirements have been reduced by one hour[20]. Further, the units do not have to be taken out of service for regeneration of the mineral. The $KMnO_4$ is added by a positive displacement pump.

Westview, Pennsylvania water department reports a reduction in organic compounds in the iron removal plant effluent. E. L. Keck and H. F. Shea report that one hour downtime per day and 35,000 gpd of backwash and rinse water are saved[21]. $KMnO_4$ is added to the influent water by means of a positive displacement diaphragm pump. A 0.6 to 0.9 ppm chlorine residual is maintained in the distribution system.

Melcher, Iowa operates a manganese treated greensand pressure filter plant to combat 4.0 to 6.0 ppm of iron. Potassium permanganate is added continuously at the rate of 0.5 ppm perpart of combined iron and manganese in the raw water[22]. Soda ash is used to adjust pH to slight alkalinity.

Wilkinsberg, Pennsylvania filter plant applies chlorine, lime, potassium permanganate, alum, and polyelectrolyte in that order to Allegheny River water. Prior to addition of 1.2 ppm potassium permanganate to remove manganese, chlorine dioxide had been used, but the required pH range (8.5-9.0) caused deposition of calcium carbonate on the filters[15].

References

1. Houston, Sir Alexander, 15th Annual Reports to the Metropolitan Water Board, London, England.
2. Houston, Sir Alexander, 19th Annual Reports to the Metropolitan Water Board, London, England.
3. Houston, Sir Alexander, 20th Annual Reports to the Metropolitan Water Board, London, England.
4. Houston, Sir Alexander, 21st Annual Reports to the Metropolitan Water Board, London, England.
5. Houston, Sir Alexander, 25th Annual Reports to the Metropolitan Water Board, London, England.
6. Wolman, Abel; Donaldson, Wellington; Enslow, L. H. *JAWWA*, **22**:1161, (1930).
7. Enslow, L. H. *JAWWA*, **20**:83 (1928).
8. Data from plant reports analyzed and assembled by C. R. Cox, Assistant Engineer, N. Y. State Dept. of Health, Albany, N. Y.
9. Scott, R. D. 8th Annual Report of Ohio Conference on Water Purification. (Nov. 1928).
10. Harrison, L. B. *JAWWA*, **21**:1 (1929).
11. Kirchoffer, W. G. Fe and Mn Removal by Catalytic Reagents. *Public Works*. p. 30, (July 1936).
12. Griffin, A. E. *JAWWA*, **52**:1326 (1960).
13. Nordell, Eskel. *Jour. Florida Engineering Soc.*, **2**:5, (1954).
14. Saunders, D. J. Iron Removal and H_2O Softening. *Water & Sewage Works*. (March 1951).
15. Adams, Reginald B. *JAWWA*, **52**:219 (1960).
16. Carus Chemical Co. Research Staff, LaSalle, Ill.
17. Panzica, N. E., Supt. Water Works, Peru, Ill. Personal Communication.
18. Smith, J. L., Supt. Water & Sewer Dept., Waxahachie, Texas. Personal Communication.
19. Campbell, S. J. & Boyle, Edward J., Consultants, Acme Labs., Inc., Cornwell Heights, Pa. Personal Communication.
20. Marvin, Loren W., Chairman of Board of Water Commissioners & Gustafson, Norman A., Supt. Water Works, Borough Colchester, Conn. Personal Communication.
21. Keck, Ernest L., Lab. Technician & Shea, Harold F., Plant Supt., Municipal Authority of the Borough of Westview Water Dept., Westview, Pa. Personal Communication
22. Willey, B. F., Technical Director, Elgin Softener Corp., Elgin, Ill. Personal Communication.

Major Expansion of Jamaica Water System Planned

A $42 million water supply expansion program for the capital city of Kingston, and fifty entirely new water systems to supply the entire island of Jamaica, West Indies was disclosed by the Jamaica Industrial Development Corporation.

The report from Carroll C. da-Costa, United States Director of the Jamaica government agency said the Kingston water system development is calculated to take care of the expanding needs of the city for the next 30 years. It includes the drilling of additional deep wells at Caymanas and enlargement of the city's filtration plant at Seaview.

Meanwhile, the Jamaica government is planning, with U.S.—ICA assistance, the development of an island-wide integrated water supply system. The plan is being based on a survey prepared by a U.S. team of ICA consulting engineers. It calls for fifty coordinated systems to serve present and future needs of all urban and rural communities outside of the corporate area of Kingston.

Initially, complete plans and specifications for the first thirteen systems are to be prepared by an engineering firm specializing in water treatment and distribution. The firm also will estimate costs for the additional 37 water systems which when completed will supply the island's entire 4400 square mile area.

Contracting costs for the first thirteen systems is estimated at $200,000 of which $100,000 is being supplied by the United States through the International Cooperation Administration. The ICA will supply a sanitary engineer to assist the Jamaica Ministry of Home Affairs in the implementation of the program.

D. C. To Accept Bids for Sewer & Tunnel Work

The District of Columbia Department of Sanitary Engineering announces that bids will be taken during 1961 on approximately $25,000,000 worth of sewer and tunnel work on the Potomac Interceptor which connects the Dulles International Airport to the District of Columbia sewage system.

Contractors bidding on those portions of the work situated in Virginia will be required to be registered with the Virginia State Registration Board for Contractors.

Mr. David V. Auld is Director of Sanitary Engineering and Mr. James W. Head, Jr., is Chief Engineer, Office of the Potomac Interceptor. Consulting engineers are Black & Veatch and Burns & McDonnell of Kansas City, Mo.

Keep 'em Rolling

by C. G. Cunningham

■ IT MAY SEEM ELEMENTARY, but be sure to keep spark plug holes covered anytime you tear down one of your trucks, diggers ready-mixers or tractors. The accompanying picture shows what can happen when a foreign object drops in the plug hole and is not found.

The piston shows heavy pitting—and all from a spark plug terminal nut that fell into the plug hole during a minor tune-up.

If something does get into a plug hole, try getting it out one of these two ways: First, if the object is metal, try a magnet. If this doesn't work try the second method. Rock over the engine until both valves on that piston are closed. Then, take a small piece of copper tubing and bend it to form a straight hook. With the tubing attached to an air chuck, build up full pressure on your compressor, then insert the tubing into the spark plug hole and direct the compressed air in all ways. The air pressure will probably blow the object right out through the plug hole.

It's much easier to keep the objects out of the plug hole than it is to fish one out.

Remind your mechanics to take it easy on hydraulic track adjusters on the crawlers. Some of the mechanics still give the adjusters an extra tug for good measure. This can make your tracks too tight. Overtight tracks cause excess wear and loss of power. Check on your track rigs to be sure the adjusters are set correctly.

If you have any alternators on your trucks, you'll want to make sure that all of your men know the danger of reversing the electrical polarity of the systems. Reversing it will burn out the wiring harness and may damage the alternator itself. Remind them to be careful of:

- Attaching a new battery. Be sure before attaching cables that the negative cable is mated to the negative post and positive cable mated to the positive post. Otherwise, you reverse polarity and—no wiring!
- Use of fast charger. Both battery cables must be disconnected from the battery before connecting the fast charger to the truck's battery. Never use a fast charger as a booster to provide starting voltage.
- Booster battery use. Here again, be sure the negative terminal of the vehicle battery is mated with the negative lead from the booster. Connect the leads this way in parallel.

It might be a good idea to attach a special "Alternator in use here" sign on your fleet cars and trucks with alternators. All new Dodge trucks have them, plus any 1961 Chrysler Corporation cars. Print on the tag a warning about the three areas of caution needed in connection with alternators. Might save you a re-wiring job.

Many times a hot engine is hard to start. This can be caused by excessive fuel vapors in the intake manifold, a result of percolating or spill-over from the carburetor fuel

bowl. When this happens, there is a shortage of oxygen in the manifold. No oxygen—no fire!

Solve the problem by opening the throttle wide open to bring in a fresh supply of oxygen and flush out the manifold. Do this by pressing the accelerator to the floor until motor starts.

Remind all of your drivers, operators and supervisors that safety is not a campaign or a promotion, safety is a state of mind. Men can be trained to think *safety* by constantly being reminded of safe work and driving habits.

Get more wear and better mileage out of your truck tires. B. F. Goodrich suggests: know more about your tires and how to take care of them. They offer these tips:

Over-inflation and under-inflation are two tire wear causes. Over-inflation can seriously damage your tires. It does not compensate for overloading. It does not add strength to the tire. In fact, it actually weakens the cord body by reducing its ability to absorb road shocks.

Over-inflation leads to: rapid wear in the center portion of the tread; increased tendency toward bruises and impact breaks; excessive strain on beads and rim; abnormal tire growth, stretching of tread and tread cracking; abnormal stresses and strains in the tread that lead to separation; more cuts and snags; harder riding and reduced cushioning leading to increased upkeep cost on equipment; reduced traction and skid resistance because less tread contacts the road.

Under-inflation is bad too. Tires are designed to operate at certain recommended inflations which provide normal flexing with proper deflection and road contact. Under-inflation leads to: tread wear on shoulders; irregular tread wear; excessive heat causing ply separation; increased tendency to bruise and tread separation.

For the best tire wear, inflate to recommended pressures when tires are cool. Check pressure regularly. Tighten valve caps, catch slow leaks. Lower tire pressure if your load is usually below maximum. Never bleed tires to relieve build-up. If excessive build-up does occur, either your load or speed or both must be reduced. Use the type and size tire that has the correct capacity for your load. Check tires, save your checkbook!

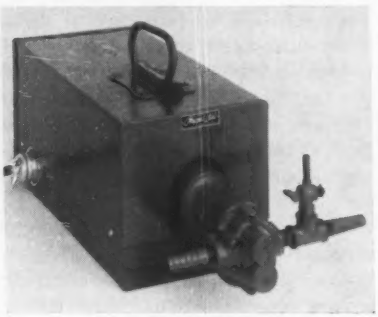
EQUIPMENT IN THE NEWS

For further information on products or services please use reader service card.

Slurry Pumps

501

A new line of "JC" slurry pumps, smaller than its present RX heavy-duty line has been announced by this manufacturer. Excellent hydraulic and abrasive characteristics allow the new pump to operate on less horsepower and help extend the long life of its wearing parts.

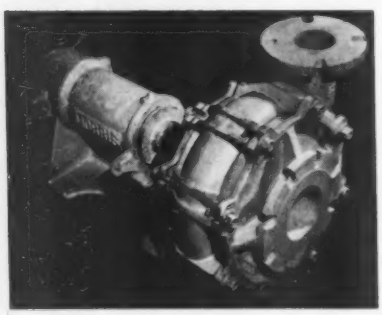


Depending upon the intended application, the pumps are available in medium, hard, or extremely hard metal casings, impellers and liners. The "JC" series includes eleven models in six sizes; 1, 1½, 2, 2½, 3 and 4 in.— Morris Machine Works.

Effluent Sampler

502

Pumping type effluent sampler, only 7½ x 8½ x 18 in. overall size, is portable. Motor and clock controls are housed in a sturdy metal case with carrying handle.



Unit operates for 15 seconds at regular intervals of 15 minutes. Pump capacity is 4 gpm; however, lesser volumes of collected sample may be obtained by adjusting a bypass valve. The pump lifts liquid to a height of 6 ft.—Phipps and Bird, Inc.

Plastic Drainage Fittings

503

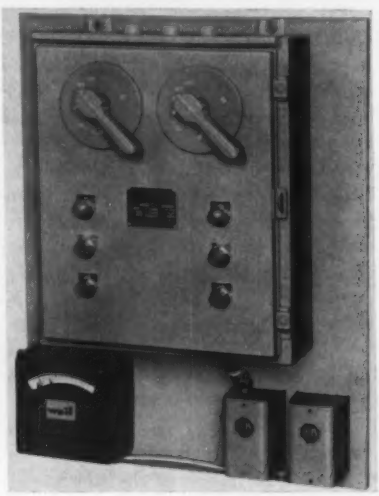
A new type of plastic drainage fittings, designed for use with the manufacturer's bitumized fibre pipe. Duropipe, will stand great abuse and still retain its usefullness as a root-proof fitting. It has a smooth interior for unrestricted flow; it is lightweight and has a high crush and impact resistance.

The new fittings are available in 4 in. adapters, Y's, T's, ⅛ in. and ¼ in. bends.—Sonoco Products Co.

Automatic Pump Control

504

A new automatic pump control and liquid level indicator has recently been introduced by the manufacturer. Designated the Vis-A-Trol, it is designed for use with submersible sewage and sump pumps, vertical type sewage and sump pumps and septic tank effluent pumps.



The Vis-A-Trol automatic control system is combined with a depth measuring device which show the depth of liquid in pit. It can be installed inside buildings as far as 300 ft. away from the pumping pit or in weatherproof enclosures on the outside. The panel and instrument is a factory wired unit including starters, alternators and high water alarms.—Weil Pump Co.

Aquatic Weed Herbicide

505

Aquathol is the name of a new aquatic weed herbicide recently introduced after 5 years of intensive research and field tests. It can be used safely in recreational areas, lakes, and fish ponds.

The new herbicide destroys underwater weeds, floating weeds, and algae by contact action and is not harmful to fish when applied at recommended dosages. The average normal dosage is at 1 and 2 parts per million which is far below the point of toxicity to fish.—Agricultural Chemicals Div., Pennsalt Chemicals Corp.

Sewage Pump Control

506

The RS-3 Roto-Trol is a pressure operated sewage pump control for starting and stopping one or more pumps discharging out of a wet well. A built-in time delay device keeps the last pump operating until the end of the compression pipe is clear. For this reason, the compression pipe will never become waterlogged. The Roto-Trol can be located wherever desired, as the only connection between it and the compression chamber, in the wet well, is a length of copper tubing.—Healy-Ruff Co.

Automatic Engine Controls

507

New automatic control has been designed especially for underpass and pipeline pumping. It is a program timer control for use on gas, gasoline or diesel engines and is encased in a steel, weather-proof enclosure.

The control includes one of the company's standard automatic engine controls together with a timer driven by a governed dc motor. All current is taken from the engine battery so that no commercial power is required for their operation. Many variations are available, including safety protection for all abnormal conditions.—Synchro-Start Products, Inc.

Water Meter Scale Removal

508

A mild chemical solvent is now available that may be used to overcome the hazards and problems encountered in descaling all types of water meter equipment, and where accuracy has been reduced by restrictions to the flow of water.

This solvent eliminates the need to use destructive acids and their concomitant fumes. After the scale has been removed, only a rinsing in hot water is required before reassembly. The solution may be used repeatedly and does not deteriorate with age.—Skosal Corp.

Chemical Liquid Meter

509

Model B N V is the latest Chemical Liquid Meter added by Buffalo Meter Co. to its line of Niagra Liquid Meters.

Especially designed for small flows, the new meter is ¾ in. size and supplements the 1-inch and 2-inch sizes previously manufactured. It will handle a wide variety of chemical liquids including most acids, alkaline solutions, deionized water and edible oils.—Buffalo Meter Co.

Water Meter

510

Recently introduced by the manufacturer, the Easy-Read Magnetic Drive Meter is a disc-type meter which drives a sealed gear train and register unit through a magnetic coupling.

Stuffing box leaks and reading difficulties caused by lens fogging have been completely eliminated. The self contained register assembly may be removed, even under water, without opening the meter housing or disturbing the meter in the line.

The magnetic coupling is 30 times more powerful than the register load it drives and utilizes permanent magnets made of a ceramic material which is chemically inert and virtually impossible to demagnetize.—Badger Meter Mfg., Co.

Bell-and-Spigot Gasketed Joints for Steel Water Pipe

511

Steel water pipe in diameters from 24 in. through 120 in. ID, and in 40 ft. lengths, with bell-and-spigot rubber gasketed joints is now available from Bethlehem Steel Co. in the East and Midwest. Widely used in the Far West, this type of pipe joint reduces considerably the cost of laying large-diameter steel water mains, since a joint can be completed in a small fraction of the time required for mechanically coupled or welded connections.—Bethlehem Steel Co.

Wall-Mounted, Low Cost Chlorinizer

512

A new, low cost chlorinizer, compact and simple in design, which mixes chlorine gas with water and feeds the resultant solution, has been recently introduced. The Model 845 Chlorinizer mounts on a wall and is especially suited for sterilization of drinking water, swimming pool water and sewage or waste treatment effluent. It will feed in ranges of 2-28, 5-50 and 10-100 lbs. per 24 hours. All parts in contact with the chlorine gas and the solution are made of corrosion-resistant materials.—B-I-F Industries, Inc.

Coagulant Aid

513

"Aquafloc" is the trade mark for a new group of coagulant aids designed for more efficient removal of suspended and precipitated solids from water in sedimentation tanks, clarifiers, softeners, or filters.

Used either alone or with standard coagulants, the new coagulant aids reduce treatment costs while improving results. Included in the product series are: #420, a highly effective non-ionic coagulant aid; #422, which may be used in potable water systems, and #425, which has an anionic form that produces excellent results when floc is positively charged.—Dearborn Chemical Co.

Pre-Shaped Saddle Fittings

514

Pre-Shaped saddle fittings previously produced mainly in 90 degree angles are now available in 45 degree angles.

Manufactured of high-strength seamless tubing in three weight schedules, the new fittings come in A-53 for most piping requirements and A-106, Grade B for higher pressure applications. Sizes range from 1 in. through 12 in. for welding and 1 in. through 4 in. for threaded filling. Special fittings 1 in. through 36 in. in aluminum, alloy or stainless steel are available in any desired angle.—Allied Piping Products Co.

Curb Valves

515

A new line of curb valves, identified as "Oriseal", is now available. While retaining the many advantages of a plug type valve, the "Oriseal" overcomes most of the disadvantages. Easy turning is one important feature, even in larger sizes after prolonged idleness.

Top and bottom O-rings of equal size positively seal both ends of the plug and prevent leakage. Positive pressure sealing at the port is provided by an O-ring in a specially designed groove located in the body around the outlet port. The entire surface of the plug is coated with Teflon, assuring easy turning without lubrication or periodic maintenance.—Mueller Co.

Mill Ruptures Microorganims

516

A new mill has been designed for rupturing large quantities of microorganisms. Called the "Eppenbach Micro-Mill", the unit will reduce slurries and bacteria, spores, molds, yeast and pollen granules in hopper capacities ranging from 150 ml to 2 liters. Capacities up to 5 gallons are available and larger sizes can be made on special order.

The mill is powered by a 1.5 hp motor with speed controls from 0 to 10,000 rpm monitored by a continuously variable transformer.—Gifford-Wood Co.

News of Suppliers

Philip W. Morgan Dies

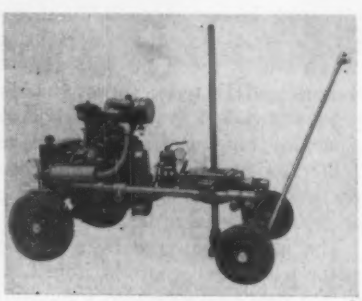
Chicago Pump regretfully announces the death of its consultant, Philip F. Morgan, Professor of Sanitary Engineering, State University of Iowa, on January 19, 1961. Professor Morgan's professional career was concentrated in practically all of the phases of sanitary engineering, with emphasis on sewage treatment.

Professor Morgan was associated with the Mellon Institute for Industrial Research at Kalamazoo, Michigan, becoming a fellow of the National Council for Stream Improvement. He took charge of the Sanitary Engineering program at the State University of Iowa in 1948, and subsequently developed an outstanding research program in sewage treatment. In connection with this program, he developed a continuing group of graduate students supported by contract research.

Payne Dean & Company, Clinton, Conn.

Truck-mounted, hydraulic valve operators provide fast, safe control of 10″ to 60″ valves

One Man Control of Speed and Torque on Gate Stem with Indication. Two Safety Control Devices.



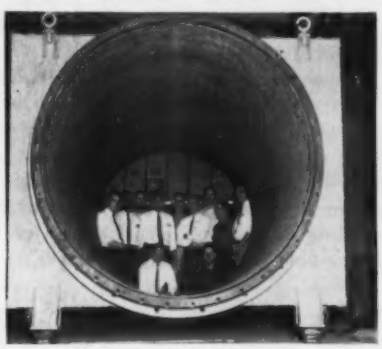
4-Speed Electric Motor Gatenders. For Floor-Stand and Under Floor Operation. 1 to 5 HP 10" To 36" Valves.

Portable Engine Driven Gatenders, For Valves 10" to 36". All Hydraulic Operation. Two Safety Features.

World's Largest Magnetic Flowmeter Built by Fischer & Porter

The largest magnetic flowmeter ever manufactured, a 7-ton giant that has a 78 in. diameter metering tube, has been completed by the Fischer & Porter Company of Warminster, Pa.

The meter, which is 7½ ft high x 16½ ft long x 8¾ ft wide and weighs 24 tons when filled with water, has been built for the Seadrift, Texas plant of the Union Carbide Chemicals Company. When installed, it will be used to meter water being pumped from the plant's cooling water basins; the reading taken by the meter will be used in determining the company's water bill. The meter has a maximum standard potential capacity of 450,000 gallons per minute, though only a third of this capacity will be utilized at this time. It has an accuracy of ±1%.



Because this meter will be in service outdoors, it has been fully waterproofed for protection against the elements. However, the unit is designed to operate fully submerged in water should its waterproof barriers be destroyed. The tube of the meter is made of stainless steel and

is completely lined with Neoprene. All internal fixtures are stainless steel. Almost a mile of wire was used by F & P in developing the magnetic field for the meter; yet it does not require much more power than that required for many household appliances—it draws 35 amps on 110 volts ac.

Martin Paulson Joins B-I-F

Martin B. Paulsen of Wayne, Pa., recently a member of the engineering staff of American Water Works Service Company in Philadelphia, is now Utility Systems Engineer with B-I-F Industries, Inc., Providence, R. I.

Mr. Paulsen brings to his new assignment many years of experience in the technology of Water Utilities, a field in which B-I-F has pioneered for many years. He will be increasingly concerned with advanced applications of automatic systems and supervisory control.

Streator Clay Pipe Names Rinehart V.P.

Streator Clay Pipe Co., Streator, Ill., has announced that Ray G. Rinehart, for eleven years Michigan and Indiana district manager for James B. Clow & Sons, Inc., Chicago, has been appointed vice president and assistant general manager of the Streator Clay Pipe Company, a recently purchased Clow subsidiary at Streator, Illinois.

Rinehart, whose headquarters have been in South Bend, is well known throughout the waterworks industry in the Midwest. He is a member of the executive committee of the Indiana section of the American Waterworks Association of which he is past chairman.

K-S

ELECTRONICALLY CONTROLLED PNEUMATIC SEWAGE EJECTORS

with the new Komline-Sanderson

uses only 1 Single, Short Probe

The finest, most reliable pneumatic sewage ejectors are now equipped with the most advanced innovation in electronic liquid level control, a development of Komline-Sanderson research. K-S electronic liquid level controls provide:

- Completely transistorized control systems.
- Resistance type control, to establish desired discharge cycle from 10 to 70 seconds.
- High water alarm incorporated in the design.
- Single, short probe that does not require cleaning.

Also available for installation on your present ejectors.

Write for Bulletin 10

MECHANICAL EQUIPMENT DIVISION
KOMLINE-SANDERSON ENGINEERING CORPORATION
PEAPACK, NEW JERSEY
CANADIAN OFFICES AND PLANT
BRAMPTON, ONTARIO, CANADA

New Literature

AVAILABLE FREE

Centrifugal Dewatering Pumps 517

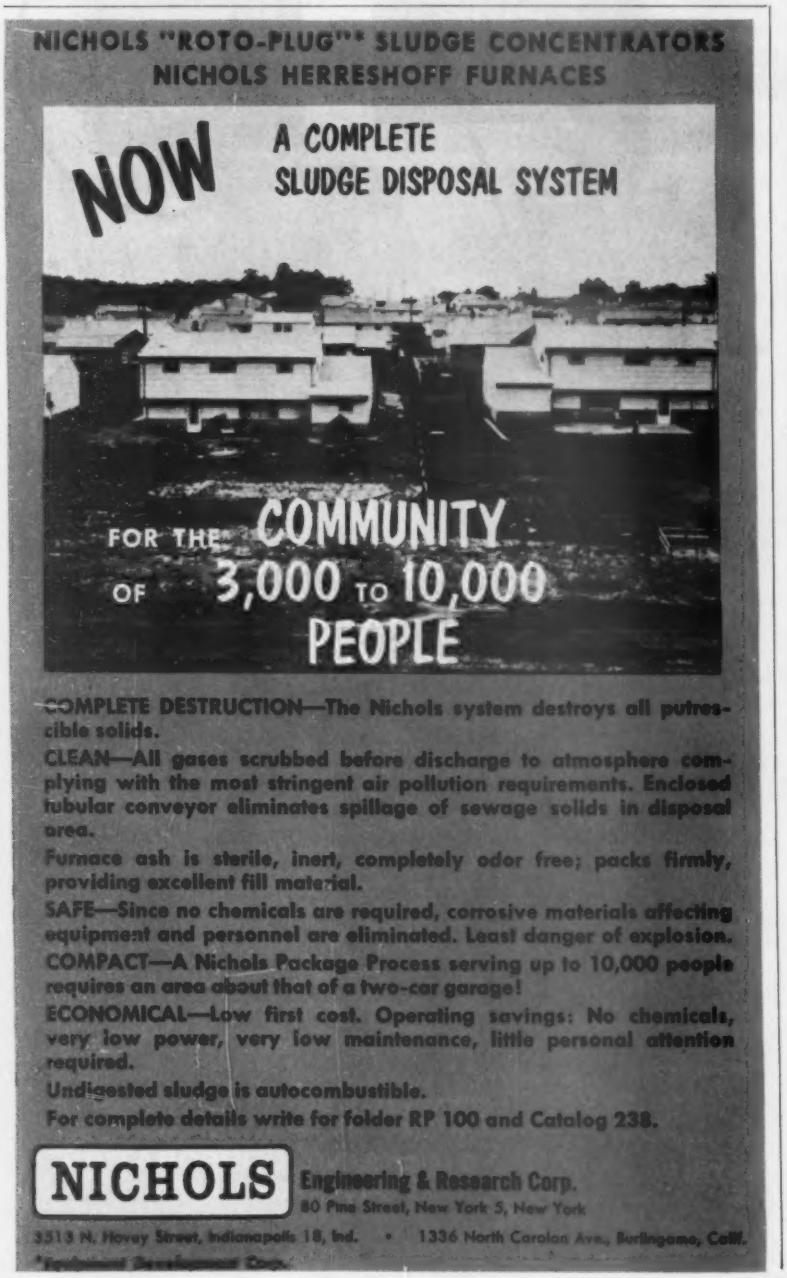
An 8-page, thoroughly illustrated bulletin provides the specifications of a 3 in. electric motor-driven submersible centrifugal dewatering pump. The bulletin lists the various applications of the unit and contains on-the-job photographs.

A colored cutaway drawing shows the main features of the pump, and a performance table is included.—Gorman-Rupp Co.

New Method of Shipping Cast Iron Pipe 518

A new "Palletizing" method of shipping cast iron pipe, designed to lower handling costs and thus reduce the overall cost of purchase, is described in a 4-page bulletin. The method enables the utility or distributor to handle larger quantities of pipe more conveniently because it has been "packaged" on pallets at the factory and shipped to the destination where it may be either unit or individually unloaded.

Not only are shipping and handling problems eased by this method but storage problems are equally simplified because the pallets lend themselves to convenient stacking and placing.—Griffin Pipe Div., Griffin Wheel Co.


NICHOLS "ROTO-PLUG"* SLUDGE CONCENTRATORS
NICHOLS HERRESHOFF FURNACES
NOW
A COMPLETE
SLUDGE DISPOSAL SYSTEM
FOR THE COMMUNITY
OF 3,000 TO 10,000
PEOPLE
COMPLETE DESTRUCTION—The Nichols system destroys all putrescible solids.
CLEAN—All gases scrubbed before discharge to atmosphere complying with the most stringent air pollution requirements. Enclosed tubular conveyor eliminates spillage of sewage solids in disposal area.
Furnace ash is sterile, inert, completely odor free; packs firmly, providing excellent fill material.
SAFE—Since no chemicals are required, corrosive materials affecting equipment and personnel are eliminated. Least danger of explosion.
COMPACT—A Nichols Package Process serving up to 10,000 people requires an area about that of a two-car garage!
ECONOMICAL—Low first cost. Operating savings: No chemicals, very low power, very low maintenance, little personal attention required.
Undigested sludge is autocombustible.
For complete details write for folder RP 100 and Catalog 238.
NICHOLS
Engineering & Research Corp.
60 Pine Street, New York 5, New York
3513 N. Hovey Street, Indianapolis 18, Ind. • 1336 North Carolan Ave., Burlingame, Calif.

Micro-Straining Story 519

Now available is a 4-page bulletin that outlines the installation and performance of a micro-straining plant at Marston Lake, a source of Denver's water supply.

On-the-job photographs illustrate how the installation was made and how the micro-straining project operates.—Glenfield and Kennedy, Inc.

Psychoda Fly Control 520

The control of psychoda flies in trickling filters is described in a 4-page bulletin and two reprints from two magazines in the sewage and wastes treatment field. The articles describe how RSC insecticide was used to control this problem in two particular treatment plants where other chemicals failed.

On-the-job photographs are provided in the literature and tables are presented which compare this insecticide with the performance of others. This chemical has proven to be effective in controlling DDT resistant insects.—Glenn Chemical Co., Inc.

Microwave for Public Utilities 521

Public utilities, now eligible for microwave licensing under the FCC's recent ruling, can use the LMR20, 6 kmc, microwave communication system. New 12-page bulletin describes this system, a flexible transmission medium for telephone, telegraph, teleprinter, protective relaying and telemetering, supervisory control, monitoring, data and other communicating signals.

Photographs of the units and their components are provided and a list of performance specifications is included. The principal ordering in-

formation is provided, and the bulletin's text presents a full explanation of the unit's construction, operation and construction.—Lynch Communications Systems, Inc.

Sewer and Culvert Pipe

522

A 68-page catalog on concrete and culvert pipe is available. It contains nine sections of the latest engineering information on machine-made roller, suspension, cast, special, reinforced concrete pressure, and reinforced concrete subaqueous pipe.

Each section is preceded by detailed general information on the products catalogued; this information is consistent, thus facilitating quick case reference for construction, applications and sizes.

The catalog also contains technical bulletins and other information that provides engineers with design criteria for concrete sewer and culvert pipe.—Lock Joint Pipe Co.

Coagulation Chemicals

523

The chemistry of coagulation applied to effective water treatment in municipal and industrial plants, practical approaches to problems, and solutions are discussed in an 8-page illustrated brochure, Bulletin A-1. Among the processes described are: application of sodium aluminates; refined montmorillonites; cationic, anionic and non-ionic polymers; and a new concept of "Inline Clarification".

Photographs augment the text material which explains the principles of coagulation and coagulating chemicals.—Nalco Chemical Co.

Valve Controls

524

The Limitorque automatic, power actuated device for controlling all types of valves, sluice gates and water tight doors is comprehensively described in a new 16-page bulletin. Illustrations include numerous cutaway drawings, performance and dimensional tables, diagrams and photographs of the unit.

In the event of a power failure, the Limitorque can be manually operated by means of a powerful handwheel control. All major components and features of this unit are described, and a typical parts list of a unit is provided.—Philadelphia Gear Corp.

Water Storage

525

20-page brochure illustrates and describes advantages and uses of the manufacturer's extensive line of Horton steel reservoirs and standpipes.

Main function of reservoirs and standpipes is to provide an adequate water supply and overcome low pressure in a water distribution system during the peak demand period.

Both reservoirs and standpipes can supply water for distribution systems by gravity pressure or by means of pumps. Reservoirs are larger in diameter than height. Standpipes are just the opposite. Storage capacities range from 50,000 to 10,000,000 gallons.—Chicago Bridge & Iron Co.

Pneumatic Sewage Ejector

526

Recent bulletin describes in detail this manufacturer's pneumatic sewage ejector system.

The pneumatic ejector only operates at full capacity while performing useful work. Total electrical

CONTINUED ON PAGE 102A

G-A CUSHIONED ALTITUDE CONTROL VALVE

Regardless of the size of the elevated tank, the Golden Anderson Altitude Control Valve automatically maintains a constant water level and prevents overflow. Available in sizes 2" to 36", this valve is normally housed in an underground pit to protect from inclement weather.

Bulletin W-4B has complete technical data.

Golden Anderson Valve Specialty Company

1254 RIDGE AVENUE, PITTSBURGH 33, PA.

Designers and Manufacturers of VALVES FOR AUTOMATION

New Literature

CONTINUED FROM PAGE 101A

power consumption is usually considerably less in this system than in the centrifugal pump.

The information presented in the bulletin covers details of the functioning, construction, typical installation and specifications.—Blackburn-Smith Mfg. Co., Inc.

Waste Treatment Equipment

527

8-page Bulletin No. 315-11 presents general information on this manufacturer's extensive line of waste treatment equipment used by industry and municipalities.

Different types of screens, triturators, grit and sludge collectors, skimmers, flocculators, mixers and separators by flotation are described and illustrated.—Chain Belt Co.

Electric Check Valves

528

8-page bulletin describes an electric, double-cushioned, check valve used primarily on pump installations. The operation of these valves, especially designed to eliminate water hammer, is illustrated by means of diagrams and charts that show the unit's performance characteristics and construction features.

Sizes of these range from 2 to 36 in.—Golden-Anderson Valve Speciality Co.

Efficient Filtration of Swimming Pool and Industrial Process Water

529

8-page bulletin discusses in detail the economic and efficient filtration of swimming pool or industrial process water. It describes and illustrates the equipment required, such as Circular and Flat Leaf Vacuum Filters, a Compact Screw Type Feeder and a Compact Chlorinizer. The combination of these components with accesory equipment forms a packaged filtration system that provides maximum efficiency and is economical.—B-I-F Industries, Inc.

Spring and Diaphragm Actuators

530

A new bulletin on pneumatic spring and diaphragm actuators has been issued by the manufacturer.

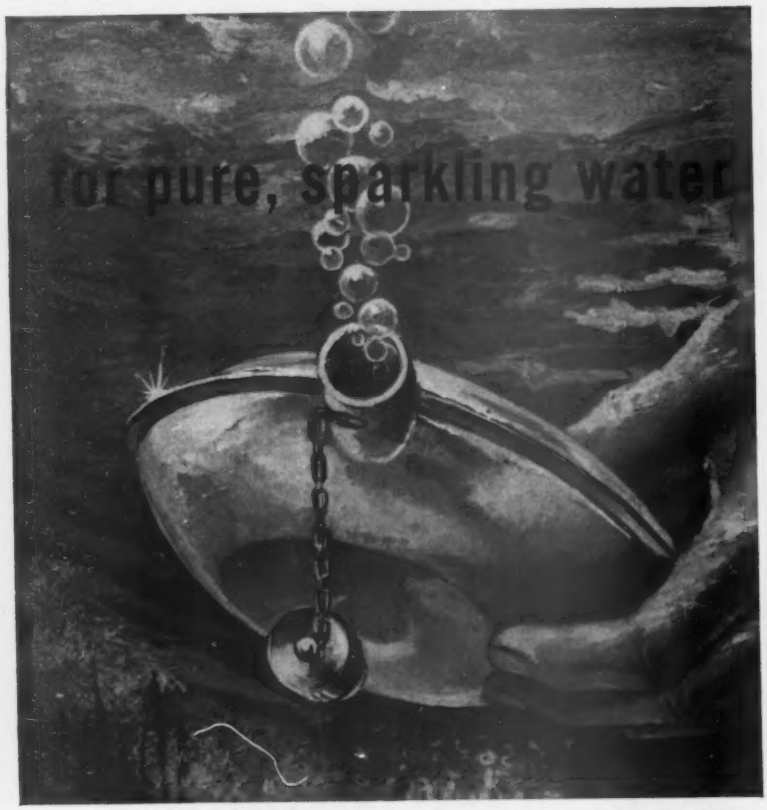
Four-page bulletin B-1020-7 illustrates and describes Series B-10 and B-20 spring and diaphragm actuators, available in complete valve assemblies to customer specifications. Bulletin shows actuators in various typical combinations including a butterfly valve, adjustable port valve, burner valve, etc. Complete specifications, operating characteristics and dimensions are listed.—Conoflow Corp.

Pneumatic Valve Position Transmitter

531

A revised 2-page bulletin recently issued by the manufacturer describes the Model AVPT Pneumatic Valve Position Transmitter, a compact, accurate device for translating position into proportional output pressure.

Operating on the Force Balance principle and designed for either rotary or straight-line motion, the AVPT Transmitter is intended for numerous applications in which the knowledge of the position of a remote mechanism is important for accurate control of processes.—B-I-F Industries, Inc.



TRIANGLE BRAND COPPER SULFATE

Small, economical dosages of Triangle Brand Copper Sulfate will make your water supply palatable. It destroys algae and aquatic weeds that cause bad water odors and give water an unsavory taste. ■ Another important use of Triangle Brand Copper Sulfate is for the control of root growths, fungi and slime in sanitary sewers and storm drains without damaging trees and shrubs. ■ Write today for complete information on the use of Triangle Brand Copper Sulfate in water supply systems, sewers and drains.

phelps dodge refining corporation

300 PARK AVENUE • NEW YORK 22, NEW YORK

Mechanical Air Separators
532

16-page bulletin describes in detail the manufacturer's line of Mechanical Air Separators.

It illustrates and explains the design features of Single and Double Separators and presents detailed diagrams of the equipment, pertinent technical data covering the various types of materials to be processed, and listings of tables of sizes and specifications,—The Raymond Div., Combustion Engineering, Inc.

Cast Iron Pipe and Fittings
533

196-page Catalog No 54 offers complete technical data on this manufacturer's extensive line of cast iron pressure pipe and pipe fittings, valve boxes and other castings. Information includes weights, dimensions and specifications.—Alabama Pipe Co.

Purification Systems
534

6-page bulletin describes American Schreiber Co.'s method of assembling predesigned biological sewage treatment plants from concrete blocks and prefabricated components.

The brochure includes photographs and diagrams of: a compact, complete sewage treatment plant; multiple septic tank systems; Imhoff tank systems; and a trickling filter plant embodying settling, high rate filters and digestion tanks in a single unit.—American Schreiber Co.

Plastic Parshall Flume Liner
535

2-page bulletin illustrates and describes a new, one-piece, precision-molded Parshall Flume Liner recently added to the manufacturer's extensive line of Differential Producers.

Sturdily constructed of polyester resin reinforced with fiberglass, it is available in throat sizes from 3 in. to 8 ft to measure flow in open channels in ranges from 10 gpm to 210,000 gpm. The bulletin contains illustrations, dimensions, advantages and typical specifications. —B-I-F Industries, Inc.

Cast Iron Pipe and Fittings
536

80-page general catalog presents this manufacturer's extensive line of cast iron pipe and fittings, fire hydrants, gate valves and hydraulic machinery.

The description of each product includes complete technical data, specifications, design features and useful tables of weights and dimensions.—R. D. Wood Co.

Recording Fluorometer
537

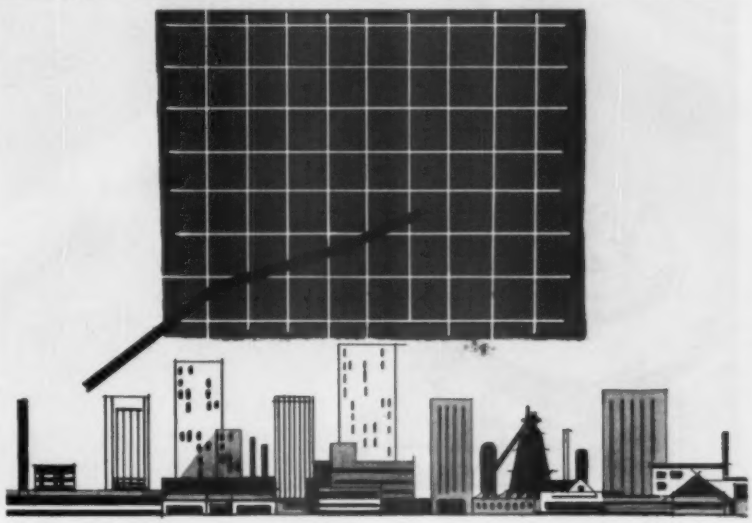
Data sheet describes the Turner Model 111 Self-Balancing Fluorometer, which provides both direct readout and outputs for various types of recorders and controllers.

Literature explains the optical-bridge design, the automated operation, and the sensitivity of 0.02 ppb quinine sulfate, which makes this fluorometer useful in the fields of trace analysis, clarity determinations, air and water tagging, and other fluorescence measurements.—G. K. Turner Associates.

Eccentric Plug Valves
538

4-page Bulletin AE-1059-B describes and illustrates the manufacturer's W-K-M Eccentric Plug Valve

CONTINUED ON PAGE 104A



The Future

It appears that the demand for M & H valves and hydrants will increase in the "60s", for four reasons: (1) Rapidly increasing population, (2) growing industrial economy, (3) superior quality of M & H products, (4) need of improvements and expansion of water and sewerage facilities.

Although over 17,000 water distribution systems have been built in about 75 years, in over 1,000 of them water consumption has recently been rationed. Engineers estimate that some 60% of all U. S. water supply systems now need major improvements. This situation could easily get worse instead of better due to rapidly increasing population – expected to be 227 million by 1975. A new American is born every 12 seconds or 7,500 new water consumers every day! The U. S. Department of Commerce estimates that in the next 20 years, water supply facilities will need to be doubled, costing approximately $41 billion.

That is going to take valves, hydrants and fittings. We lay no claims to sorcery or clairvoyance. We have no crystal ball, cannot tell the future. But with modesty and humility, we believe engineers will specify that a lot of those valves shall be M & H.

(No. 12 of a Series)

M&H VALVE
AND FITTINGS COMPANY
ANNISTON, ALABAMA
SUBSIDIARY OF WALWORTH

New Literature

CONTINUED FROM PAGE 103A

designed for flow control in sewage plants and water works.

In addition to explaining the main features and advantages of these valves, the bulletin includes a series of tables giving construction and performance data.—W-K-M Div., A C F Industries, Inc.

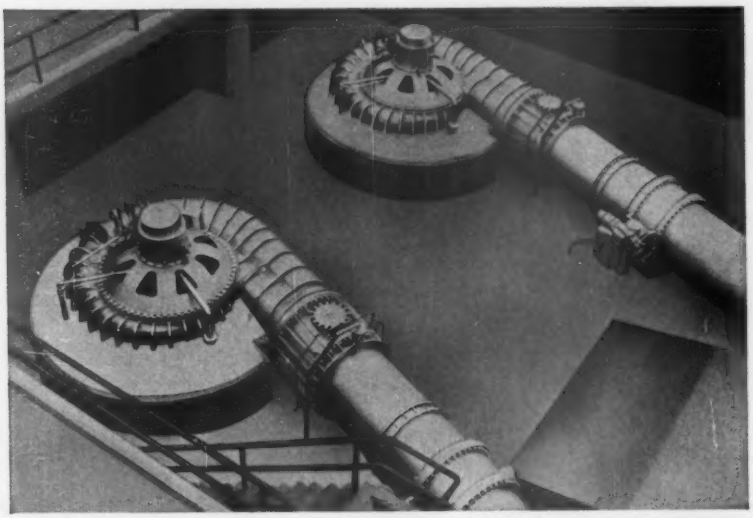
Anthracite Filter Medium

539

18-page technical bulletin describes in detail the characteristics and advantages of this manufacturer's hard-coal filter medium identified under the trade name of "Anthrafilt".

Anthrafilt is used in place of sand and gravel in all kinds of filters, such as: rapid gravity, pressure or slow filters; process softening filters; mechanical sewage filters; revolving screen filters; sewage sludge-beds, and others.

In addition to technical data, the bulletin includes filter data questionnaire sheets and specification sheets. —Anthracite Equipment Corp.



YOU'RE looking at two C. H. Wheeler 67,000 gpm Vertical, Bottom Suction, Side Discharge, Mixed Flow Dual Volute Pumps. They are operating at the Helena Valley Pumping Plant of the Bureau of Reclamation's Missouri River Project. These pumps provide sufficient irrigation water to permit the farming of 17,500 previously unproductive acres of Montana farmland.

The C. H. Wheeler Dual Volute design is especially valuable when a pump is required to operate over a wide range of operating conditions.

Both pumps have side discharge. An unusual C. H. Wheeler designed bottom suction permits taking water from the same penstock that drives the Water Turbines.

High-head, high-capacity pumps such as these have unlimited application in municipal water supply and irrigation services . . . another instance of applying C. H. Wheeler design to special pumping problems, with assurance of proper performance.

C. H. WHEELER MFG. CO.

PHILADELPHIA 32, PA.

Affiliates: GRISCOM-RUSSELL • KLIPFEL VALVES

Centrifugal, Axial and Mixed Flow Pumps • Sea Water Distilling Plants • Finned Tubing • Heat Exchangers • Steam Condensers • Ejectors • Marine Steering Gears & Auxiliary Equipment

pH Meters

540

Features, applications, and specifications of the Beckman Model G and GS pH Meters are reported in a new bulletin recently issued.

Model G is used for research analyses, routine pH and millivolt determinations, and quality control applications.

Model GS is a Modification of Model G, employing two additional operating controls to provide 20 times greater meter sensitivity and an eight-fold increase in readability. —Beckman Scientific and Process Instruments Division.

Determining Chloride Content of Water

541

2-page data sheet issued by this manufacturer describes a continuous automatic method for determining chloride content of water in concentrations down to 10 parts per billion.

The complete chemical methodology is detailed. A flow diagram of the analytical system is included. The same methodology, using a larger flow cell, will determine even smaller concentrations.—Technicon Controls, Inc.

Aluminum Grating

542

6-page brochure illustrates and describes this manufacturer's Gary Galok Aluminum Grating, which offers a high strength-to-weight ratio, minimum deflection, greater installation ease and maximum safety.

Engineering data presented in this brochure includes a Table of Safe Loads, typical designs and tables on weights and dimensions.—Rockwell-Standard Corp.

Electronic Data Processing for Small Utilities

543

A recent brochure explains how smaller utilities can gain the advantages of electronic data processing. Through the use of Univac Service Centers, operated by this manufacturer, small utility companies can make use of modern electronic bill-

ing heretofore available only to larger firms.

These centers are designed to serve small companies who find it impractical to invest in or even rent the costly equipment.—Remington Rand Div., Sperry Rand Corp.

Double Disc Valves for Concrete Pipe

544

6-page Circular No. 26 describes and illustrates the advantages of installing M & H Double Disc Valves in a prestressed concrete pipeline, without adapters.

The valves are available with O-ring hub joints in sizes 12 in. through 42 in. The large O-ring gaskets, which connect the valve hub to the concrete pressure line, meet AWWA specifications.

M & H gate valves for prestressed concrete pipe can be furnished with gearing, either spur or bevel type, outside packed gear case and with or without watertight gland enclosure. Valves buried underground should have gear cases with gland enclosure. Valves installed in pits do not need a gland enclosure.—M & H Valve and Fittings Co.

Transite Pressure Pipe

545

8-page Bulletin TR-160A, recently published by Johns-Manville, describes the advantages of Transite Pressure Pipe for use in water mains.

In addition to tabular data giving the sizes and weights of Transite asbestos-cement pressure pipe in the three available classes, the bulletin includes photographs and drawings which explain the methods of manufacture, quality control, installation and assembly.—Johns-Manville.

Air Valves

546

This manufacturer's extensive line of Crispin air valves is covered in detail in 26-page Catalog R. Illustrations, complete specifications and explanations of operating characteristics are given for each type of Crispin air valve, including: Air and Vacuum Valves, Deep Well Air Valves, Pressure Air Valves, Model "P" Air Valves, Midget Air Valves, Combination Air Valves, Universal Air Valves, Dual Valves, Sewer Valves, Turbine Valves and Negative Pressure Valves.—Multiplex Mfg. Co.

Products and Services

547

4-page brochure presents a useful guide to the many and diversified products and services offered by General American Transportation Corporation through its numerous divisions. Among the subsidiaries, serving the water and sewage field are: Fuller Co.; Sutorbilt Corp.; and Dracco Division.—General American Transportation Corp.

Protection Against Corrosion

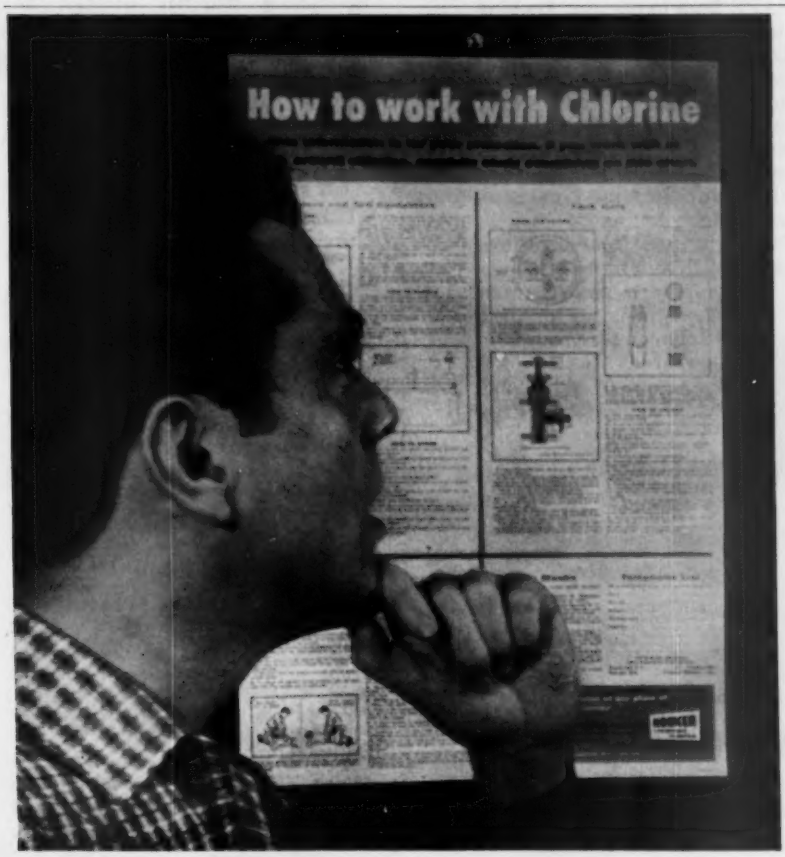
548

8-page bulletin describes the use of the manufacturer's Bitumastic Protective Coatings as a solution to a wide variety of corrosion and deterioration problems.

The coatings, which are applied cold by brush, spray, and roller, are each designed to meet specific problems—underground corrosion, water exposure, corrosive atmospheres, chemical and mechanical destruction of steel, etc.

In addition to covering the properties and specification data on nine major Bitumastic products, the brochure lists scores of typical installa-

CONTINUED ON PAGE 106A



YOU CAN'T BE COMPLACENT ABOUT SAFETY

Workmen can pass a safety chart a dozen times a day. You can plaster work areas with signs and slogans. Yet a lapse of attention, a moment's carelessness, and there might be trouble.

When dealing with potentially hazardous chemicals, correct procedures cannot be overemphasized. This is why we supply safety charts . . . and write books like our 76-page chlorine manual. If you need more charts and would like a copy of the chlorine book, please let us know.

HOOKER CHEMICAL CORPORATION
1705 UNION STREET
NIAGARA FALLS, N.Y.

HOOKER CHEMICALS PLASTICS

Sales Offices: Buffalo, Chicago, Detroit, Los Angeles, New York, Niagara Falls, Philadelphia, Tacoma, Worcester, Mass.

In Canada: Hooker Chemicals Limited, North Vancouver, B. C.

New Literature

CONTINUED FROM PAGE 105A

tions requiring corrosion protection. —Koppers Co., Inc., Tar Products Div.

Sanitary Water Analysis

549

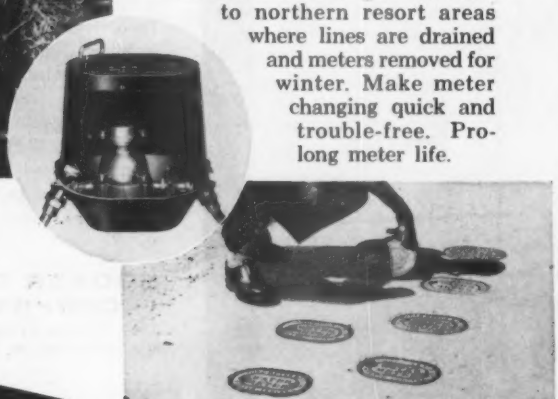
The membrane filter technique for sanitary testing of water is described in detail in Manual #7, an 8-page bulletin recently published by Gelman Instrument Co. The method has been approved by the National Research Council, the California State Water Pollution Board and the USPHS.

Whereas the standard confirmed test requires 2-4 days for results, the membrane technique needs only 16-20 hours. In addition, the membrane method allows the use of larger and more representative samples than are used with other methods.

The membrane filter is a thin plastic sheet which will filter bacteria from water. A disk of membrane is placed in a special type-M funnel and a sample of water filtered through it by means of suction. The membrane is then placed on a paper pad moistened with media and incubated for 16-20 hours. Coliform colonies can readily be identified and counted because of their typical metallic sheen. The membrane filter can be used for examination of drinking water supplies, sewage, beverages and foods. —Gelman Instrument Co.

Strong as a
SAFE
yet easily handled by one man

The FORD YOKEBOX keeps shallow service meters—SAFE from dirt, insects, or larger pests. Cast iron, unbroken barrier on all sides. Keeps dials clean for fast, accurate reading. SAFE from tampering. Locking lid opens only with *lifter* key. Lockless lid also available.
SAFE for pedestrians. Anchor lugs (optional) prevent settling in concrete.
Each Ford Yokebox includes service valve, expansion coupling and service line connections.
Proven for year 'round settings as far north as Virginia. A boon to northern resort areas where lines are drained and meters removed for winter. Make meter changing quick and trouble-free. Prolong meter life.



Battery setting easily read with one stop.

FORD
for *better* water services
THE FORD METER BOX COMPANY, INC., Wabash, Indiana

Tubular Conveyor

550

A complete reference folder containing information on the Hapman Chain-Flight Tubular Conveyor is available.

These conveyors consist of solid circular flights of Neoprene (or special materials), mounted at intervals on special, sealed-pin chain or wire cable operating within standard pipe or tubes. They move almost any powdered, granular and semi-liquid material through any plane or angle, with minimum clearance and outside support. Being dust-proof, liquid-tight, odor-confining and self-cleaning, these conveyors are often used where sanitation is vital.—Hapman Conveyors, Inc.

Preventing Scale Deposition, Corrosion and Pitting

551

A brochure recently issued by this manufacturer shows how costly wastage of fuel and deterioration of equipment can be prevented by effective treating of water.

Bulletin describes the variety of chemicals offered, identified as Formula #105, Formula #116, etc., to prevent scale, corrosion and pitting. —Industrial Chemicals, Inc.

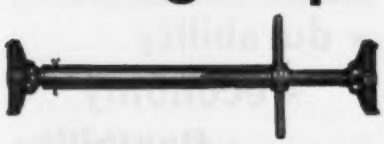
Water, Sewage and Industrial Waste Treatment

552

64-page Catalog 952 deals exclusively with the manufacturer's extensive line of equipment for water, sewage and industrial waste treatment plants.

The catalog describes design features, operation and advantages of screens, screening grinders, travel-

safest way to dig deep



SIMPLEX
DROP-FORGED STEEL
TRENCH BRACES

- the only braces made of all drop-forged steel
- safest, strongest, most efficient and economical
- prevents cave-ins
- eliminates costly re-digging

Blunt safety-lever nut prevents damage, injuries. Ball-and-socket joints, plus lugs at each end, give quick set and tight grip at all angles. Nailing holes at both ends. Pipe sleeve adapts brace to any trench width. Overall closed lengths, with pipe, from 18" to 60", screw extensions from 7" to 10". Also available without pipe.

Get all facts, write for Mechanical Catalog

SIMPLEX
RE-MO-TROL UTIL-A-TOOL JACKS JENNY ROL-TOE

TEMPLETON, KENLY & CO.
2560 Gardner Road • Broadview, Illinois

ing water screens, grit collectors and washers, settling tanks, flocculators, garbage grinders and auxiliary equipment.—Jeffrey Mfg. Co.

Filter Underdrains

553

Porous media for filtration and diffusion is the subject presented in a 55-page technical bulletin.

It explains and illustrates the manufacturer's Aloxite underdrain system of ceramic bonded plates for use in water filters, softeners, etc., eliminating graded gravel support for filter media. The information offered in this bulletin should be particularly helpful to technicians throughout the process industry and sanitary engineering fields.—The Carborundum Co.

Butterfly Valves

554

Bulletin No. 5904, a 32 page brochure, gives complete information on the Darling—Pelton Rubber Seated Butterfly Valve.

Bulletin presents design features, construction details, dimensions, operation and very useful technical data. General hydraulic information is also included.—Darling Valve & Mfg. Co.

Water Pre-Treatment

555

8-page Bulletin No. 9141 gives general information on the manufacturer's extensive line of equipment and methods for the pre-treatment of water for the removal of turbidity, color or hardness prior to filtration.

Bulletin illustrates and describes Pre-sedimentation Thickners, Flash Mixers, Slakers, Flocculators, Clarifiers, Monorakes, Clariflocculators, Sludge Pumps, Sludge Thickners and Hydro-Treators. It includes basic design data and flow diagrams.—Dorr-Oliver Corp.

Municipal Supplies

556

98-page general Catalog No. 163 presents the extensive line of municipal supplies available from this manufacturer. Among the important items used in the water and sewage field included in the catalog are: transistorized or electric pipe, valve and leak detectors: magnetic dipping needles; precision gauge testers;

CONTINUED ON PAGE 108A

SUTORBILT BLOWERS FOR EFFICIENT SEWAGE TREATMENT

• Sutorbilt 3200 Series Blowers for large air capacity needs.

High performance and low maintenance are assured with these precision machined, positive-pressure blowers and gas pumps. They deliver 800 to 23,000 cfm of clean, dry air at pressures from 2 to 12 psig. Available with timing gear diameters from 10" through 26" in horizontal designs. Many sizes also offered with vertical case arrangements. Ideal for aeration of grit chambers, channel aeration, pre-aeration flotation, flocculation, tank aeration, air lifts, gas recirculation. For specifications, Send for Bulletin S-32-A.

• Features of Sutorbilt Blowers:

TWO-PIECE CASE, strongly ribbed to prevent distortion

ONE-PIECE 4140 FORGED STEEL SHAFT, slip-fitted through impellers, attached at gear ends, allowing increased pressure and horsepower ratings with complete safety

OVERSIZE ROLLER BEARINGS, in cartridges for easy removal

HELICAL ALLOY TIMING GEARS, piloted to shaft and bolted to timing hub

CLOSE-GRAIN IRON IMPELLERS, precision bored to receive shaft

MACHINED SUB-BASES as standard equipment

LUBRICATION by force-feed pressure system

• Sutorbilt blowers for smaller capacity requirements — California B Series Blowers . . . for higher speeds, greater outputs.

Thrust bearing on drive shaft permits V-belt or direct drive. Steel timing gears for extra long service. Dynamically balanced impellers for high-speed operation. Write for Bulletin S-59-I, Dept. H.

Sales representatives in principal cities

4471
5-59

SUTORBILT CORPORATION
IT WILL HOLD

2966 EAST VICTORIA ST. • COMPTON, CALIF.
Subsidiary of Fuller Company • Catasauqua, Pa.

It's NEW for HEAVY-DUTY SEWAGE USES

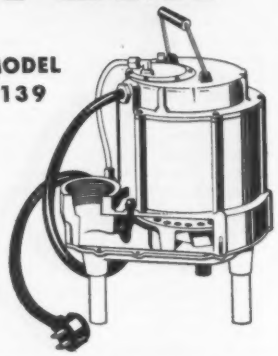
KENCO®

HIGH CAPACITY 8600 GPH at LOW HEAD 5 ft. Head

6800 GPH at 10-ft.

PUMP

MODEL 139



- Completely Submersible
- Rugged Cast-Bronze Construction
- Extra-Deep 2-Vane NON-CLOG Impeller
- 2" NPT Discharge
- Extra Powerful Pumping Action
- Shreds sewage and other solids for dependable non-clog performance
- Leg supports—threaded to use any standard ½" pipe for readily adjustable stand

See Your Wholesaler A-3608A

KENCO PUMP

Division of The American Crucible Products Co

1305 Oberlin Avenue • Lorain, Ohio

New Literature

CONTINUED FROM PAGE 107A

sewer tools; hydraulic root cutters; sewer cleaning machines and many others.—W. S. Darley & Co.

Corrosion Prevention

557

Technical Bulletin TP-118-E explains this manufacturer's improved system of cathodic protection, called Automatic Potential Control, especially suitable for protecting submerged or buried structures.

Bulletin shows how automated system protects structures against corrosion at varying potentials when climatic or environmental conditions change.—Electro Rust-Proofing Corp.

Plastic Pipe Manual

558

35-page loose-leaf engineering manual describes in detail Evanite plastic pipe and fittings.

Technical data includes sections on physical properties and chemical resistance, flow factor and design, abrasion resistance, supporting strength and crushing tests, determination of trench backfill loads, and lining of existing sewers.—Evanite Plastic Co. Div., Evans Pipe Co.

Synchronous Motor

559

Bulletin 1100-PRD- 253 describes a line of heavy duty, synchronous motors in rating of 600 hp and up. These are "full power" machines built for extra-duty applications. They feature a husky, steel frame, heavy shafts, oil pressure type, sleeve bearings with quick view sight gauges and high capacity starting windings.

The line is offered in speeds from 500-1800 rpm, at 0.8 or 1.0 power factor, 60—50 cycles and at all standard voltages.—Electric Machinery Mfg. Co.

Water Works Promotion

560

"Water—Make Sure You'll Always Have Plenty", A 16-page brochure, presents a complete plan for local support of water system improvements. It shows how civic-minded citizens can learn from their

Re-new your structures with GUNITE!

★ durability

★ economy

★ flexibility

- DAMS
- RESERVOIRS
- TUNNELS
- GRAIN ELEVATORS
- BREAKWATERS
- CONCRETE TANKS
- FILTER PLANTS
- STADIUMS
- SEA WALLS
- PIPE LINES
- SEWERS
- STACKS
- BRIDGES

estimates, specifications and surveys made free of cost to you. write, wire or call MElrose 4-8120

INDIANA GUNITE & CONSTRUCTION CO., Inc.

ENGINEERING—CONSTRUCTION

CONTRACTS TAKEN ANYWHERE

Box 600 • Florence, Ala.

INDIANA GUNITE & CONSTRUCTION CO., INC.
1734 Villa Ave. • Indianapolis, Ind.
Gentlemen: Please have a representative contact me.
I am interested in:
Description:.....
.....
.....
NAME.....
STREET.....
CITY.....STATE.....

public officials the needs and plans of their community.—Cast Iron Pipe Research Assn.

Setting and Testing Equipment for Water Meters

561

New Ford Catalog No. 62 offers a complete listing of this manufacturer's extensive line of equipment for setting and testing water meters.

It includes items not shown in previous catalogs, such as Plumbhorns and Pretzelhorns for basement and utility room settings, Inter Americana Meter Boxes, Compression Ringstyle Valves, Lead-Pak Couplings, Pack Joint Pipe Couplings and Meter Shop Equipment.

An informative section on fundamentals discusses the economic and engineering factors pertinent to the setting of water meters and the choice between inside and outside settings. —The Ford Meter Box Co., Inc.

Motion Safety Switch

562

4-page bulletin describes and illustrates an improved type motion safety switch for protecting machines, equipment and processes against damage resulting from stoppage or reduced speed.

Bulletin describes design, installation and operation of the improved switch. Two installation photographs and a cutaway drawing of the switch are included.—Fuller Co.

Aluminum Grating, Sluice Gates and Manhole Covers

563

4-page Bulletin 5e/Wa presents general information on this manufacturer's extensive line of aluminum products, including grating, sluice gates, trash racks, manhole covers, and many others.

Bulletin offers a brief description of each product illustrated with on-job photographs.—Washington Aluminum Co., Inc.

"SpaceMaker" Contactor

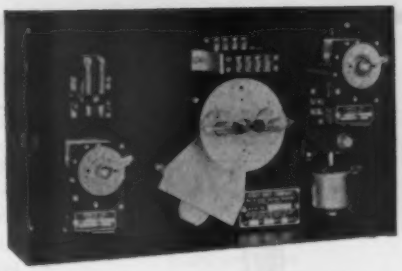
564

6-page Bulletin 14B9740 describes and illustrates this manufacturer's Type 456 SpaceMaker contactor, the first to use Pyro-Shield flame-retardent glass polyester insulation.

The new contactor is designed for starting, stopping and controlling

CONTINUED ON PAGE 110A

PRESSURE CONTROLS FOR ALL YOUR NEEDS



Healy-Ruff Company offers a complete line of easy-to-install, simple-to-use pressure-sensing controls for water works and sewage fields. Control only, or indicating and recording as well, can be supplied. All systems incorporate these desirable features:

- Ball bearing rotation and springless mechanism—measures pressure to ½% of operating range.
- Field adjustable time delays, provided where necessary to prevent start and stop surges from cycling the pumps
- Independent high and low pressure adjustments
- Minimum differential between start and stop points

THE R-4 ROTOTROL permits controlling high and low elevation of water in an elevated tank, stand pipe, or reservoir. Automatically compensates for pumping friction. Closed system and booster system controls also available. *Bulletin R-4*

THE PW ROTOTROL controls both pressure and water level in hydropneumatic tanks. Cuts off pumps on either high pressure or high level. Air-add or air-release types. *Bulletin PW-6*

THE RPS ROTOTROL controls level in pumping stations, sewage plants or reservoirs. Senses level change through corresponding change of pressure in compression bell submerged in wet well. Purged air or compression pipe types. *Bulletins RPS and RS3*

HEALY-RUFF COMPANY

783 Hampden Avenue • St. Paul 14, Minn.

First in dependable controls for waterworks and sewage—since 1929

Remote supervisory controls • Complete system controls • Elevated tank controls • Sump controls • Hydropneumatic tank controls • Float controls • Alternators • Alarm silencers • Protective devices

Magnified activated silica sol floc.

*Patent No. 2,567,285, license royalty free

WANT

CLARIFICATION RESULTS LIKE THESE?

...try Activated Silica Sol

- Reduced alum consumption saves $30.00 per day
- Filter runs extended 50%, to about 36 hours
- Best water we have ever seen

This report comes from a water company treating 30 million gallons daily. Activated silica sol was needed to solve cold water coagulating problems. Advantages prompted year-round application where they rely on "N" silicate (only ½ ppm SiO_2) fed continuously by way of the N-Sol-C Process.*

Send for Bulletin, "Treatment Of Raw And Waste Waters."

PQ

130TH ANNIVERSARY 1831-1961

PHILADELPHIA QUARTZ COMPANY

1166 Public Ledger Building, Philadelphia 6, Pa.

manufacturers of

Trademarks Reg. U.S. Pat. Off.

SOLUBLE SILICATES

Associates: Philadelphia Quartz Co. of Calif. Berkeley & Los Angeles, Calif.; Tacoma, Wash.; National Silicates Limited, Toronto & Valleyfield, Canada

PQ Plants: Anderson, Ind.; Baltimore, Md.; Buffalo, N.Y.; Chester, Pa.; Jeffersonville, Ind.; Kansas City, Kan.; Rahway, N.J.; St. Louis, Mo.; Utica, Ill.

ENSLOW

STABILITY INDICATOR

For checking the equilibrium of a finished water, and supplying an index useful in controlling anti-corrosion treatment. Catalog No. 83-895

WRITE:

Phipps & Bird, Inc.

P. O. Box 2V Richmond 5, Va.

New Literature

CONTINUED FROM PAGE 109A

large motors as well as for primary switching of induction furnace transformers and other applications up to 5000 volts where continuous current does not exceed 400 amperes. —Allis-Chalmers Mfg. Co.

Maintenance of Reservoirs by Relining 565

4-page illustrated brochure issued by Indiana Gunite and Construction Co., Inc. describes how leaking reservoirs and those which are deteriorating can be easily restored by relining with reinforced Gunite, rapidly and economically.

Before-and-after job photographs show the application of this method. —Indiana Gunite and Construction Co., Inc.

TECHNICAL SALES AND SERVICE WATER TREATMENT

Unusual opportunity for graduate chemists or chemical engineer with at least 5 years experience in water field. Must be free to travel and thoroughly familiar with municipal and/or industrial water treating systems. Salary open. Send resume of background now for interview at Detroit AWWA Convention, or after June 15th, to Mr. S. Bruce Humphrey, Director of Marketing. Carus Chemical Company, Inc., 1377 Eighth Street, LaSalle, Illinois.

SANITARY ENGINEER

For design of Water Distribution and Treatment; Combined Sewers and Sewage Treatment. Consulting Engineer in Midwest. Salary based on qualifications and experience. Box 3002, Water & Sewage Works, 185 No. Wabash Ave., Chicago 1, Illinois.

FOR SALE

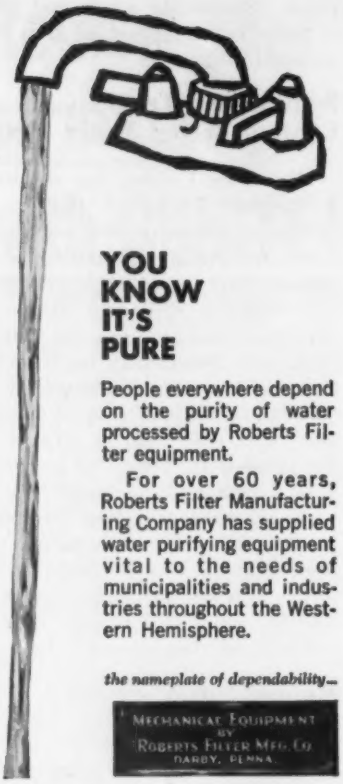
Sewage Waste Treatment Plant, used, 3 Steel Tanks, (Digester, Stone Filter, Primary Settling). Capacity 360 persons. Excellent condition. Reasonable. E. A. Perry, Walgreen Eastern Co., Inc., 100 Central Ave., Teterboro, New Jersey. Phone: Atlas 8-9310.

Rugged transistorized construction practically eliminates maintenance costs...extends battery life to a year or more. Pinpoint accuracy, greatest depth penetration make the M-scope first choice in the field! Only $189.50

Send for FREE catalog

SINCE 1932
Fisher RESEARCH LAB., INC.

Dept. WS-6, Palo Alto, Calif.



YOU KNOW IT'S PURE

People everywhere depend on the purity of water processed by Roberts Filter equipment.

For over 60 years, Roberts Filter Manufacturing Company has supplied water purifying equipment vital to the needs of municipalities and industries throughout the Western Hemisphere.

the nameplate of dependability...

MECHANICAL EQUIPMENT BY ROBERTS FILTER MFG. CO. DARBY, PENNA.

ROBERTS FILTER MANUFACTURING COMPANY
607 COLUMBIA AVENUE, DARBY, PA.

WANTED

"Senior Public Health Engineer to direct Division of Sanitation with generalized program in well established County Health Department. Population: 80,182. Vacation cumulative to 25 days, sick leave, retirement, longevity benefits. Salary: Open. Must have P.E. in N. Y. S. within 1 year and 5 years of satisfactory sanitary engineering experience. Cattaraugus County Health Department, 302 Laurens St., Olean, N. Y. Send application to Dr. Meredith Thompson, 84 Holland Avenue, Albany, N. Y. for approval."

FOR SALE

STEEL PIPE—All sizes 4" to 72" O.D. Large stocks; immediate delivery. Cutting and coating service available. Our trucks deliver anywhere in USA. To get our low, money-saving prices on one piece or a carload, write, wire or call COLLECT. VALLEY STEEL PRODUCTS CO., 124 Sidney Street, St. Louis 4, Mo.

Consulting Engineers *IN WATER & SEWAGE WORKS*

ALBRIGHT & FRIEL INC.
Consulting Engineers
Water, Sewage, Industrial Wastes and Incineration Problems—City Planning, Highways, Bridges and Airports—Dams, Flood Control, Industrial Buildings—Investigations, Reports, Appraisals and Rates—Laboratory for Chemical & Bacteriological Analyses—Complete Service on Design and Supervision of Construction.
Three Penn Center Plaza
Philadelphia 2, Pa.

Bowe, Albertson & Associates
Engineers
Water and Sewage Works
Industrial Wastes
Refuse Disposal
Valuations
Laboratory Service
75 West St. — New York 6, N.Y.
1000 Farmington Ave. — West Hartford 7, Conn.

Capitol Engine
Corporation
Consulting Civil Engineers
Dillsburg, Pennsylvania, U.S.A.

Alvord, Burdick & Howson
Engineers
Water Works, Water Purification, Flood Relief, Sewerage, Sewage Disposal, Drainage, Appraisals, Power Generation
20 N. Wacker Drive. — Chicago 6, Ill.

BOYLE ENGINEERING
Consulting Engineers
Water—Sewers—Streets
Structures—Surveys
Reports—Special Districts
331 Spurgeon Bldg. — Santa Ana, Calif.
3913 Ohio, Rm. 200 — San Diego 4, Calif.

The Chester Engineers
Water Supply and Purification—Sewage and Industrial Waste Treatment—Power Plants—Incineration—Gas Systems—Valuations—Rates—Management—Laboratory—City Planning
601 Suismon Street
Pittsburgh 12, Penna.

JOHN J. BAFFA
Consulting Engineer
Water Supply and Treatment
Sewerage and Sewage Treatment
75 West Street — New York 6, N. Y.

Brockway, Weber & Brockway Engineers
INCORPORATED
George S. Brockway — Ray E. Weber
George B. Brockway
STAFF
H. L. Fitzgerald — Ben E. Whittington
Robert E. Owen — Ernest L. Greene
Thomas A. Clark — Thomas R. Demery
Charles A. Anderson — Tom G. Lively
Civil, Structural, Sanitary, Municipal, Electrical, Land Planning
West Palm Beach, Florida — Ft. Pierce, Florida

CHAS W. COLE & SON
Engineers and Architects
3600 E. Jefferson Blvd.
South Bend, Indiana
2112 W. Jefferson St.
Joliet, Illinois

MICHAEL BAKER, JR., INC.
Consulting Engineers, Planners & Surveyors
Airport, Highway & Bridge Design; Water & Sewerage Municipal Engineering; Photo Mapping City Planning, Urban Renewal & Redevelopment Soils Lab; Complete Survey Service
HOME OFFICE: ROCHESTER, PA.—Baker Bldg., P. O. Box 111
Jackson, Miss. Northview Drive P.O. Box 9997
Charleston, W. Va. 19 Dunbar St. P.O. Box 2148
Harrisburg, Pa. 2799 N. Fourth St. P.O. Box 790

Buck, Seifert and Jost
Consulting Engineers
Water Supply, Sewage Disposal, Hydraulic Developments, Reports, Investigations, Valuations, Rates, Design Construction Operation Management, Chemical and Biological Laboratories
112 East 19th St. — New York

CONSOER, TOWNSEND & ASSOCIATES
—CONSULTING ENGINEERS—
Sewage treatment, sewers, storm drainage, flood control—Water supply and treatment—Highway and bridges—Airports—Urban renewal—Electric and gas transmission lines—Rate studies, surveys and valuations—Industrial and institutional buildings.
360 East Grand Avenue, Chicago 11, Illinois

Betz Laboratories, Inc.
CONSULTING ENGINEERS
INDUSTRIAL WASTE
INDUSTRIAL WATER
ANALYSIS — DESIGN
INVESTIGATIONS — OPERATION
Gillingham & Worth Sts.
Philadelphia 24, Pa.

BURGESS & NIPLE
Civil and Sanitary Engineers
Water Supply and Purification
Sewerage and Sewage Treatment
Appraisals, Reports, Valuations
2015 West Fifth Avenue
Columbus 12, Ohio

MR. CONSULTING ENGINEER
Are you interested in both
WATER & SEWAGE
If so there is no better place for your professional card than in this dual interest magazine.
Water & Sewage Works

BLACK & VEATCH
Consulting Engineers
Sewage—Waste Disposal—Water
Electricity—Industry
Reports, Design, Supervision of Construction, Investigations, Valuations and Rates
1500 Meadow Lake Parkway
Kansas City 14, Missouri

BURNS & McDONNELL
Engineers—Architects—Consultants
4600 E. 63rd St. Trafficway
Kansas City 41, Missouri

CRAWFORD, MURPHY & TILLY
Consulting Engineers
Water Works—Impounding Reservoirs
Highways—Municipal Streets—Expressways
Traffic Problems—Airports—Swimming Pools
Sewers—Sewage Treatment—Wastes Treatment
Storm Drainage—Flood Control—Surveys & Reports
LAKESIDE 8-5419
755 So. Grand Ave., W. — SPRINGFIELD, ILL.

CLINTON BOGERT ENGINEERS
CONSULTANTS
Clinton L. Bogert — Ivan L. Bogert
Donald M. Ditmars — Robert A. Lincoln
Charles A. Manganaro — William Martin
Water & Sewage Works • Incinerators
Drainage • Flood Control
Highway and Bridges • Airfields
145 East 32nd Street, New York 16, N. Y.

Camp, Dresser & McKee
Consulting Engineers
10 Tremont Street, Boston 8, Mass.
Water Works and Water Treatment; Sewerage and Sewage Treatment; Municipal and Industrial Wastes; Investigations and Reports; Design and Supervision; Research and Development; Flood Control.

ROY B. EVERSON
Water Treatment Service Since 1900 for Swimming Pool Circulating Systems. Purification Systems as applied to Sewage Treatment and Water Works. A New System for Automatic Control.
233 W. Huron Street, Chicago 10, Ill.

Additional Engineers Cards on Next Page

ENGINEER ASSOCIATES
Consulting Engineers
Sewage Disposal Systems, Water Works Design, Airports, Highways and Bridges, City Planning & Engineering for Building Design
312 N. W. Eighth St.
Evansville, Indiana

FAY, SPOFFORD & THORNDIKE, INC.
Engineers
Water Supply and Distribution — Drainage
Sewerage and Sewage Treatment
Airports — Bridges — Express Highways
Port and Terminal Works — Industrial Plants
Investigations, Reports, Designs, Valuations
Supervision of Construction
11 BEACON STREET, BOSTON 8, MASS.

FINKBEINER, PETTIS & STROUT
CONSULTING ENGINEERS
Water Supply, Water Treatment,
Sewerage, Sewage Treatment,
Bridges, Highways & Expressways
2130 Madison Avenue — Toledo 2, Ohio

FULTON & CRAMER
Consulting Engineers
General Municipal Engineering Service Since 1909
Reports
Valuations
Rate Studies
Design
Construction Supervision
922 Trust Building — Lincoln, Nebraska

GANNETT FLEMING CORDDRY & CARPENTER, Inc.
ENGINEERS
Dams, Water Works, Sewage, Industrial Wastes & Garbage Disposal, Highways, Bridges & Airports — Traffic & Parking Appraisals, Investigations & Reports
HARRISBURG, PA.
PITTSBURGH, PA. — PHILADELPHIA, PA.
DAYTONA BEACH, FLA.

GILBERT ASSOCIATES, INC.
Engineers and Consultants
Water Supply and Purification
Sewage and Industrial Waste Treatment
Chemical Laboratory Service
Investigations and Reports
New York — Reading, Pa. — Washington
Houston — Philadelphia

GREELEY AND HANSEN
Engineers
Samual A. Greeley — Paul Hansen (1920-1944)
Paul E. Langdon — Kenneth V. Hill
Thomas M. Niles — Samual M. Clarke
Water Supply, Water Purification
Sewerage, Sewage Treatment
Flood Control, Drainage, Refuse Disposal
14 East Jackson Blvd., Chicago 4

Haskins, Sharp & Ordelheide
Consulting Engineers
Water—Sewage & Industrial Wastes—Hydraulics
Reports, Design, Supervision of Construction
Appraisals, Valuations, Rate Studies
1009 Baltimore Ave. — Kansas City 5, Mo.

HAVENS AND EMERSON
A. A. BURGER — H. H. MOSELEY
J. W. AVERY — F. S. PALOCSAY
E. S. ORDWAY — G. H. ASPLANALP
A. M. MOCK — S. H. SUTTON
CONSULTING ENGINEERS
WATER, SEWERAGE, GARBAGE, INDUSTRIAL WASTES VALUATIONS—LABORATORIES
LEADER BLDG., CLEVELAND 14, O. — WOOLWORTH BLDG., NEW YORK 7, N. Y.

HAZEN AND SAWYER
ENGINEERS
Richard Hazen — Alfred W. Sawyer
H. E. Hudson, Jr.
Water and Sewage Works
Industrial Waste Disposal
Drainage and Flood Control
360 Lexington Ave., New York 17, N. Y.

Henningson, Durham & Richardson
Engineers • Architects • Planners • Consultants
ENGINEERING SINCE 1917
Reports, Planning, Appraisals, Architectural Design, Highways, Bridges, Streets, Airports, Sewerage, Waterworks, Power Plants, Electrical Systems, Natural Gas Systems, Industrial Design
OMAHA — COLORADO SPRINGS — PHOENIX

The Jennings-Lawrence Co.
Civil & Municipal Engineers
Consultants
Water Supply, Treatment & Distribution
Sewers & Sewage Treatment
Reports—Design—Construction
1392 King Ave. — Columbus 12, Ohio

Jones, Henry & Williams
Consulting Sanitary Engineers
Water Works
Sewerage & Treatment
Waste Disposal
2000 West Central Ave. — Toledo 6, Ohio

KENNEDY ENGINEERS
SANITARY ENGINEERING
LOS ANGELES—SALT LAKE CITY
TACOMA—SAN FRANCISCO

Morris Knowles, Inc.
Engineers
Water Supply and Purification, Sewerage and Sewage Disposal Valuations, Laboratory, City Planning
1312 Park Building, Pittsburgh, Pa.

LOZIER CONSULTANTS, INC.
Sewerage, Sewage Disposal, Water Supply, Water Purification
Refuse Disposal
Engineers
10 Gibbs Street — Rochester 4, N. Y.

Metcalf & Eddy
Engineers
Water, Sewage, Drainage, Refuse and Industrial Waste Problems
Airports — Valuations
Laboratory
Statler Building, Boston 16

O'BRIEN & GERE
Consulting Engineers
Water Supply, Treatment and Distribution
Sewerage and Sewage Treatment
Industrial Waste Treatment—Flood Control and Drainage—Rate Studies
400 East Genesee Street — Syracuse 2, N. Y.

PARSONS, BRINCKERHOFF QUADE & DOUGLAS
Civil and Sanitary Engineers
Water, Sewage, Drainage and Industrial Waste Problems.
Structures—Power—Transportation
165 Broadway — New York 6, N. Y.

MALCOLM PIRNIE ENGINEERS
Malcolm Pirnie — Carl A. Arenander
Ernest W. Whitlock — Malcolm Pirnie, Jr.
Robert D. Mitchell — Alfred C. Leonard
MUNICIPAL AND INDUSTRIAL
Water Supply—Water Treatment
Sewage and Waste Treatment
Drainage—Rates—Refuse Disposal
25 West 43rd St. — New York 36, N. Y.
3013 Horatio Street, — Tampa 9, Florida

THE PITOMETER ASSOCIATES, INC.
Engineers
Water Waste Surveys
Trunk Main Surveys
Water Distribution Studies
Water Measurements & Special Hydraulic Investigations
New York, — 50 Church Street

LEE T. PURCELL
Consulting Engineers
Water Supply & Purification; Sewerage & Sewage Disposal; Industrial Wastes; Investigations & Reports; Design; Supervision of Construction & Operation
Analytical Laboratories
88 De Grasse Street — Paterson 1, N. J.

Rader and Associates
Engineers and Architects
Water Works, Sewers, Refuse Disposal and Other Public Works Engineering Reports. Investigations, Consultations, Plans, Specifications and Supervision of Construction Work
100 Biscayne Blvd. South, Miami 32, Fla.

ROY EDWIN RAMSEIER AND ASSOCIATES
Sanitary and Hydraulic Engineers
Water Supply, Treatment, Distribution
Sewerage and Sewage Treatment
Chemical and Bacteriological Laboratories
1539 Solano Avenue, Berkeley 7, California

Additional Engineers Cards on Next Page

ROBERT AND COMPANY ASSOCIATES
Engineering Division
ATLANTA

STANLEY ENGINEERING COMPANY
Consulting Engineers
Hershey Building, Muscatine, Iowa — 208 S. LaSalle St., Chicago 4, Ill.
Hanna Building, Cleveland 15, Ohio

Leonard S. Wegman Co.
Consulting Engineers
Refuse Disposal, Water Supply, Sewage Collection & Treatment, Highways, Bridges, Special Structures, Shore Erosion & Waterfront Works
235 East 45th Street New York 17, N. Y.

Thomas M. Riddick
Consulting Engineer and Chemist
Municipal and Industrial Water Purification Sewage Treatment, Plant Supervision, Stream Pollution Investigations, Chemical and Bacteriological Analyses.
360 East 149th Street
New York 55, N. Y.

Alden E. Stilson & Associates
Limited
Consulting Engineers
Water Supply—Sewage—Waste Disposal
Bridges—Highways—Industrial Buildings
Studies—Surveys—Reports
75 Public Square, Cleveland 13, Ohio
245 North High Street, Columbus 15, Ohio

Weston & Sampson
Water Supply, Water Purification, Sewerage, Sewage and Industrial Waste Treatment, Corrosion Control, Laboratory Service Supervision, Valuations
14 Beacon St. — Boston, Mass.

Benjamin L. Smith & Associates
Engineers
Investigations—Reports
Designs—Supervision—Valuations
Municipal Engineering and Public Utilities
11 North Pearl Street
Albany 7, New York

SWINDELL-DRESSLER CORP.
Consulting Engineers
Industrial Plants—Waterworks
Sewer Systems—Highways—Dams
Bridges—Surveys—Reports
Design and Construction Supervision
Box 1888 • Pittsburgh 30, Pa.

Whitman & Howard
Engineers (Est. 1869)
Water Supply, Water Purification, Sewerage, Sewage Disposal, Water Front Improvements and all Municipal and Industrial Development Problems, Investigations, Reports, Designs, Supervision, Valuations.
89 Broad St., Boston, Mass.

John R. Snell
ENGINEERS
Inc. 221 N. Cedar ■ Lansing, Mich. ■ IV 4-9493
Water Purification ■ Water Supply ■ Sewerage Systems ■ Sewage Treatment ■ Refuse Collection ■ Composting ■ Incineration ■ Urban Planning ■ Industrial Waste ■ Bridges and Streets ■ Soils and Foundations ■ Research and Development

Turner & Collie
Consulting Engineers, Inc.
2111 C & I Life Building
Houston 2, Texas

WHITMAN, REQUARDT & ASSOCIATES
Engineers—Consultants
Civil—Sanitary—Structural—Mechanical—Electrical
Reports, Plans, Supervision, Appraisals
1304 St. Paul Street
Baltimore 2, Maryland

FOR **fun** IN **FLORIDA**

DOCTORS Motel

Luxurious rooms with patios and balconies, free TV, radio, Hi-Fi in all rooms. Phones. Heated pool, boating, water ski lessons, fishing, golf, private beach. Restaurant and cocktail lounge on the premises. Everything for a perfect vacation. Credit cards honored.

MEMBER CONGRESS OF MOTOR HOTELS

6800 34th St., So.—U. S. 19
ST. PETERSBURG

FREE!
Write for literature and new TRAVEL GUIDE listing fine motels from coast to coast, inspected and approved by Congress of Motor Hotels.

NEW YORK CITY
for important business and leisurely pleasure

TIMES SQUARE
for 'round-the-clock entertainment and city-wide convenience

HOTEL WOODSTOCK
ALBERT FERNANDEZ, General Manager
for top-flight accommodations & service—Cocktail Lounge & Restaurant

127 WEST 43 ST.
for full color brochure and full rate information

JUDSON 2-5000
for immediate confirmation of your Woodstock reservation

YOU CAN'T PATCH IT!

Some things can't be patched, let's face it. Among them are a bond issue and a sewer line. If either fails, you start all over again—and that's expensive.

If your city puts inferior sewer pipe in the ground —and gases and acids ruin it—somebody's got to dig it up and replace it. That costs you—the taxpayer—a whole lot more money than putting down lifetime pipe in the first place.

Putting in an inferior sewer pipe is a real penny-wise, pound-foolish idea, anyway. The big cost of putting in a sewer line is tearing up streets and digging the ditch, NOT the pipe. Actually the pipe—the best, lifetime pipe—averages about only 12 percent of the cost of the job.

Lifetime pipe is Vitrified Clay Pipe. It can save you untold tax dollars in the long run.

No, you can't patch a sewer line any more than you can a bond issue. But you can patch a hole in your money pocket—and the time to patch it is before you've lost a lot of money. That means demanding lifetime pipe—Vitrified Clay Pipe—for the next sewer line in your community.

Public health is important. Your city may need to upgrade its sewer lines.

COMPRESSION SEALED, VITRIFIED
CLAY IMPERVIOUS PIPE
THE STANDARD in SANITARY SEWERS

National Clay Pipe Manufacturers, Inc.
1028 Connecticut Ave., Washington, D. C.
Find out how by writing to:

NATIONAL CLAY PIPE MANUFACTURERS, INC.
1028 Connecticut Ave., Washington, D. C.
Please send me full details on the new factory-made compression joints on Clay Pipe.

(name)
(company)
(street address)
(city and state) B-513WS

Advertisers Index

A

*Allis Chalmers 29A-32A-33A
*American Cast Iron Pipe Co. 45A

B

Badger Meter Mfg. Co. 41A
*B-I-F Industries, Inc. 39A
*Builders Providence, Inc. 39A

C

Carus Chemical Co. 8A-9A
Cast Iron Pipe Research Ass'n. 24A-25A
*Chain Belt Co. 40A
Chapman Valve Mfg. Co. 49A
*Chicago Pump Co. 19A
*Climax Eng. Mfg. Co. (Div. Waukesha) 28A
*Clow & Sons, Jas. B. 34A
Consulting Engineers 111A-112A-113A

D

Darling Valve & Mfg. Co. 36A
Dean & Co., Payne 98A
*DeZurik Corporation 46A
*Dorr-Oliver ..... Inside Back Cover

E

Eddy Valve Co. 34A
Enterprise Eng. & Machy. Co. 26A

F

Fischer & Porter Co. 44A
Fisher Research Corp. 110A
Ford Meter Box Co., Inc. 106A
*Fuller Co. 107A

G

Golden-Anderson Valve & Specialty Co. 101A

H

*Hamilton-Kent Mfg. Co. 7A
Healy-Ruff Company 109A
Hersey Sparling Meter Co. 11A-47A
Hooker Chemical Corp. 105A

I

Indiana Gunite & Constr. Co., Inc. 108A
Industrial Chemical Sales Div. West Va. Pulp & Paper Co. 15A
Infilco Inc. ..... Back Cover

J

Johns-Manville 30A

K

Keasbey & Mattison 17A-18A
Kenco Pump 108A
*Komline-Sanderson Engr. Corp. 99A

L

Layne & Bowler 4A
*Link Belt Co. 37A
Lock Joint Pipe Co. ..... Inside Front Cover

M

*M & H Valve & Fittings Co. 103A
Mortell Co. 42A
*Mueller Company 23A-27A

N

National Clay Pipe Mfrs'. Ass'n. 114A
*Neptune Meter Company 50A
*Nichols Engr. & Research Corp. 100A

O

Olin Mathieson Chem. Corp. 6A

P

*Pacific Flush Tank Company 2A
Pfaudler-Permutit, Inc. 20A
Phelps Dodge Ref. Corp. 102A
*Philadelphia Quartz Co. 109A
*Phipps Bird, Inc. 110A
Pittsburgh Chemical Co. 31A
Price Bros. 38A

R

*Roberts Filter Co. 110A
Roots-Connersville Blower Div. 35A

S

*Smith-Loveless Inc. 16A
*Sutorbilt Corp. 107A
Synchro-Start Products, Inc. 42A

T

Templeton, Kenly & Co. 107A
*Tennessee Corp. 43A

W

Walker Process Equip. Inc. 22A
Wheeler Mfg. Co., C. H. 104A
Wood Co., R. D. 1A
Worthington-Gamon Meter Div. 21A

*Advertisers represented in the 1960 Reference Number with Catalog specifications copy. Please refer to that issue for additional information concerning their product or equipment.

USE THIS **POST PAID** CARD
TO ENTER NEW SUBSCRIPTIONS

for

WATER & SEWAGE WORKS

. . . the leading monthly publication in its field for Superintendents, Operators and Engineers.

and

INDUSTRIAL WATER AND WASTES

. . . The ONLY publication devoted exclusively (and thoroughly) to the treatment of water for industrial uses AND the treatment, utilization and disposal of industrial wastes. Bi-monthly.

(see other side)

USE THIS **POST PAID** CARD
FOR READER SERVICE REQUESTS

The numbers on the card correspond to the numbers assigned to the various catalogs and other literature described in the "New Equipment" and "New Literature" sections of this issue, which are available FREE OF CHARGE.

Simply detach the card along the perforated lines, circle the items you wish to receive, fill in your name, address etc. and mail this card for our prompt attention.

(see other side)

PLEASE ENTER MY SUBSCRIPTION(S) AS INDICATED

☐ **WATER & SEWAGE WORKS, including the BIG Annual Reference Number, for.....year(s).**

Three Years—$10.00 Two Years—$7.50 One Year—$5.00

(Add $1.50 per year for countries other than the U. S. A. and Canada)

Please check your principal activity:

☐ **Sewage Only** ☐ **Water Only** ☐ **Water and Sewage**

☐ **INDUSTRIAL WATER AND WASTES, including the Annual Technical Review. One Year—$3.00.**

(Add $1.50 per year for countries other than the U. S. A. and Canada)

Please state products manufactured or processed, etc.:

Name _____

Title or Position _____

Department or Firm Name _____

Address _____

City _____ Zn ____ State _____

READER SERVICE CARD

MAY 1961

Circle the items on which information is desired. Requests will be received until July 31, 1961.

501	502	503	504	505	506	507	508	509	510
511	512	513	514	515	516	517	518	519	520
521	522	523	524	525	526	527	528	529	530
531	532	533	534	535	536	537	538	539	540
541	542	543	544	545	546	547	548	549	550
551	552	553	554	555	556	557	558	559	560
561	562	563	564	565	566	567	568	569	570
571	572	573	574	575	576	577	578	579	580
581	582	583	584	585	586	587	588	589	590
591	592	593	594	595	596	597	598	599	

If You Wish to Receive Further Information on Products Advertised or Referred to in the Articles of This Issue—List the Page and Item Below.

_____

_____

_____

Your Name _____

Title _____

Company or Dept. _____

Address _____

_____

USE THIS **POST PAID** CARD
TO ENTER NEW SUBSCRIPTIONS

for

WATER & SEWAGE WORKS

. . . the leading monthly publication in its field for Superintendents, Operators and Engineers.

and

INDUSTRIAL WATER AND WASTES

. . . The ONLY publication devoted exclusively (and thoroughly) to the treatment of water for industrial uses AND the treatment, utilization and disposal of industrial wastes. Bi-monthly.

(see other side)

USE THIS **POST PAID** CARD
FOR READER SERVICE REQUESTS

The numbers on the card correspond to the numbers assigned to the various catalogs and other literature described in the "New Equipment" and "New Literature" sections of this issue, which are available FREE OF CHARGE.

Simply detach the card along the perforated lines, circle the items you wish to receive, fill in your name, address etc. and mail this card for our prompt attention.

(see other side)

Postage Will Be Paid by Addressee

BUSINESS REPLY MAIL
First Class Permit No. 43449, Sec. 34.9, P.L.&R., Chicago, Ill.

WATER & SEWAGE WORKS
185 NORTH WABASH AVENUE
CHICAGO 1, ILLINOIS

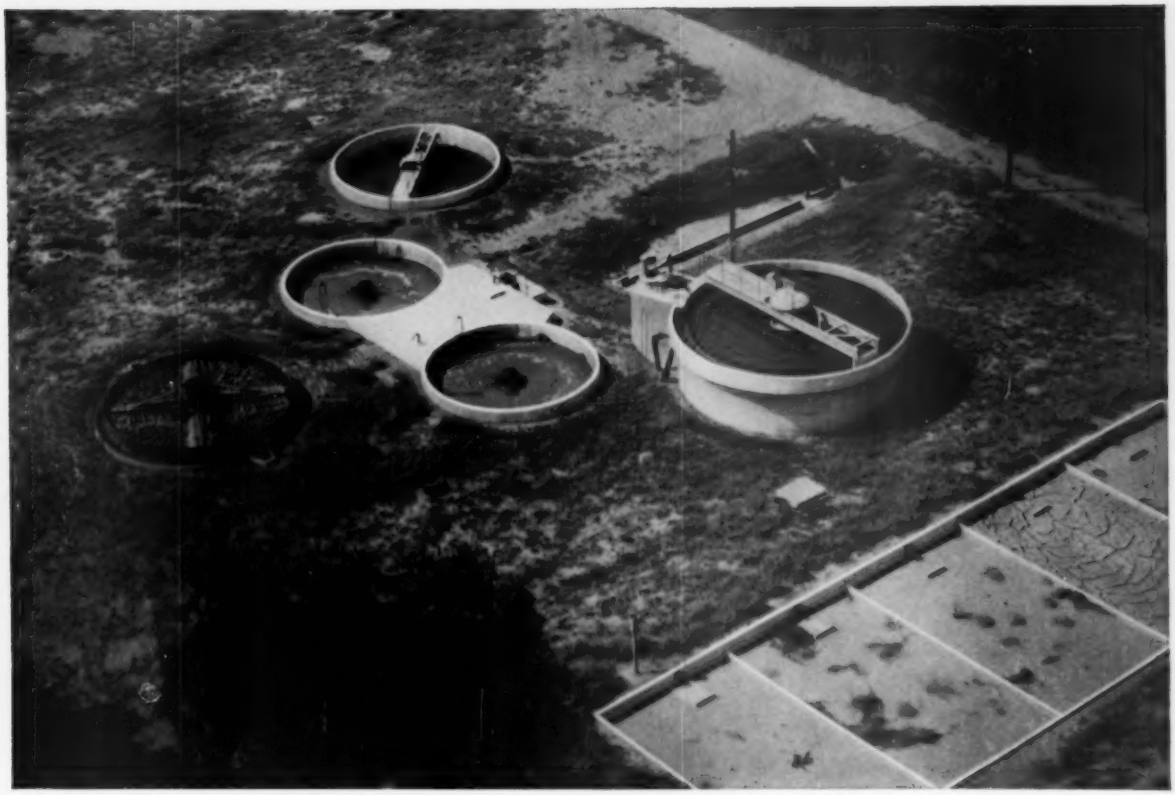
No Postage Stamp Necessary If Mailed in the United States

Postage Will Be Paid by Addressee

BUSINESS REPLY MAIL
First Class Permit No. 43449, Sec. 34.9, P.L.&R., Chicago, Ill.

WATER & SEWAGE WORKS
185 NORTH WABASH AVENUE
CHICAGO 1, ILLINOIS

No Postage Stamp Necessary If Mailed in the United States



SPIROVORTEX SYSTEM FOR CHECOTAH, OKLA.

Another new development in Activated Sludge Treatment

The sewage treatment plant shown above was placed in operation last year to serve a population of 3,500 in a recreational and agricultural area. It utilizes the Dorr-Oliver SpiroVortex System, providing B.O.D. removal in excess of 90% with low overall operating costs, simple control and capability for effective handling of widely varying loads.

Units comprise a 30′ dia. Dorr Clarigester, two 24′ dia. SpiroVortex tanks providing rapid and thorough mixing by a spiraling action, one 26′ dia. Superate Filter giving highly efficient aeration and filtering, and a 24′ dia. Dorr Final Clarifier.

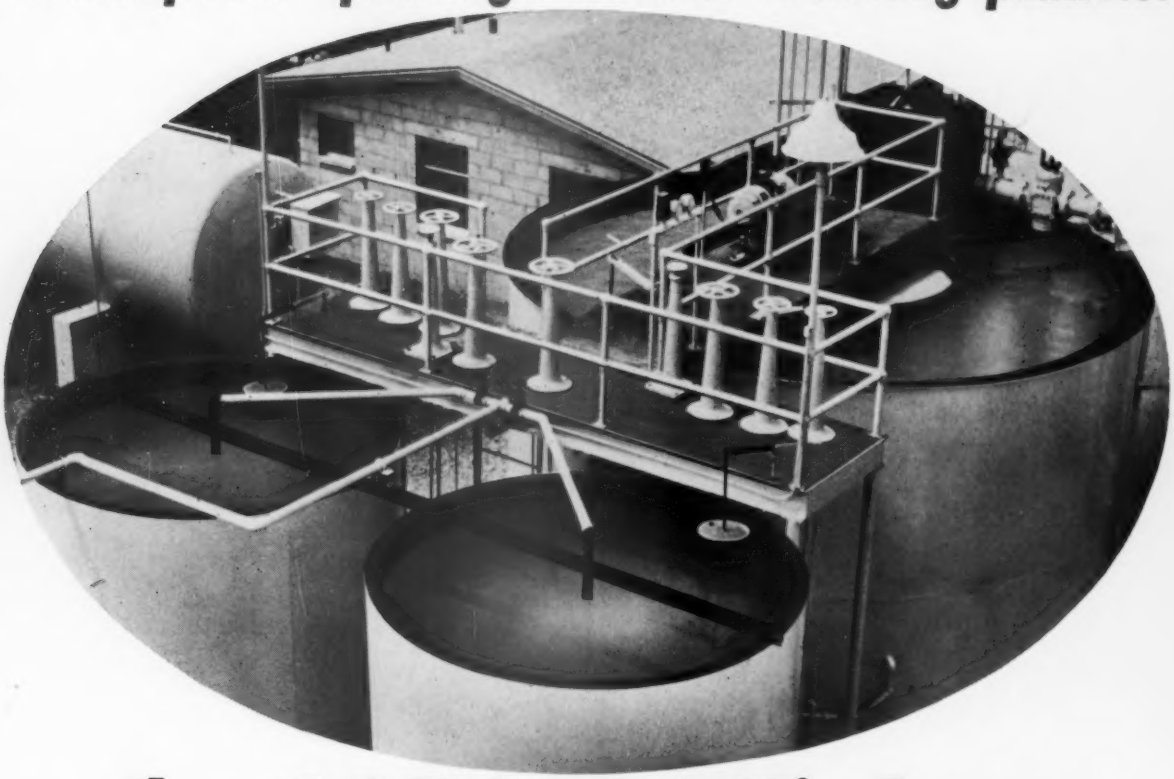
For information on the operation of the SpiroVortex System, write for Bulletin 7314 to Dorr-Oliver Incorporated, Stamford, Connecticut.

Consulting Engineers: Collins & Flood, McAlester, Okla. and Ardmore, Okla.
General Contractor: Bell Construction Company, Okmulgee, Okla.

Clarigester, SpiroVortex, Superate T.M. Reg. U.S. Pat. Off.

DORR-OLIVER
WORLD-WIDE RESEARCH • ENGINEERING • EQUIPMENT

A complete "package" water treating plant...



–the ACCELAPAK® plant

for small communities, subdivisions, motels, resorts, industries, etc.

COMPLETE—from inlet to outlet—nothing else required.

ADAPTABLE—for clarification, softening, iron or color removal, and sterilization. Pressure or gravity filters, as required.

STANDARDIZED—designed in all sizes with standardized dimensions in capacities from 15 to 350 gpm.

SIMPLE—working parts, easily accessible for minimum required attention. Simple erection and operating instructions.

DEPENDABLE—treatment results are easily obtained; uniformly and dependably maintained.

ECONOMICAL—costs of plants are low due to quantity purchasing and production; installation space is small; maximum utilization of treating chemicals is assured.

SEE YOUR CONSULTING ENGINEER if you are planning *any* installation. His services are essential for the design of the plant and selection of equipment that will best meet your requirements.

Write today for full details on the "ACCELAPAK" plant in Bulletin 1870-A or request Bulletin 80 showing our complete line of water and waste treating equipment.

516A

INFILCO

INFILCO Inc.
General Offices, Tucson, Arizona
Field offices throughout the United States and other countries.

GENERAL AMERICAN

Subsidiary of General American Transportation Corporation